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Aerosol Optical Depth and Single-Scattering Albedo in Arctic Canada

by

© Jürgen Freund

A THESIS
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Date July 27, 1982

Abstract

An increasing number of articles during the last five years have suggested that the atmosphere of the North American Arctic is subject to high aerosol loads in winter and low aerosol loads in summer. The winter maximum is said to be due to pollution probably originating in Eurasia.

To confirm or reject this hypothesis the aerosol optical depth was calculated at five, and the aerosol single- scattering albedo at one station in the Canadian Arctic. Use was made of hourly radiation data and synoptic observations.

The aerosol optical depth was calculated from a direct radiation model at Resolute and an empirical clear sky global radiation model suggested by Davies and Hay (1980) at the other four stations.

The single-scattering albedo was calculated at Resolute using the above-mentioned clear-sky global radiation model, a two-stream approximation in a one-layer atmosphere, and a two-stream approximation in a two-layer atmosphere with variable aerosol and water vapor distributions.

It turned out that the total amount and the seasonal march of the aerosol optical depth is similar at all five stations. The most outstanding feature is a short period of high aerosol turbidity in spring, followed by an abrupt decrease to low summer values. The southern and eastern stations have a second maximum in late summer. The few winter values suggest that winter is a period of rather low

aerosol turbidity.

The aerosol single-scattering albedo was found to be about 0.8. As this result has a large error of possibly as much as ±0.2 it cannot contribute to answering the question of the origin of the aerosol. The limitation of these models to calculate the aerosol single-scattering albedo is mainly due to a 5%-error in the radiation measurements.

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Nomenclature

B_a	downward to total aerosol scatter ratio for direct radiation
$B_a^{\uparrow}$	upward to total aerosol scatter ratio for diffuse upwelling radiation
$B_a^{\downarrow}$	downward to total aerosol scatter ratio for diffuse downwelling radiation
$D\uparrow(z)$	diffuse upwelling radiation at any height z
$D\downarrow(z)$	diffuse downwelling radiation at any height z
$D\downarrow \equiv D\downarrow(z=0)$	diffuse downwelling radiation at ground level
D_A	diffuse downwelling radiation at ground level due to aerosol scattering
D_R	diffuse downwelling radiation at ground level due to Rayleigh scattering
D_S	diffuse downwelling radiation at ground level due to multiple reflection
E_x	aerosol enrichment factor
H	scale height of the atmosphere
H_i	scale height of atmospheric constituent i
H_a	aerosol scale height
H_w	water vapor scale height
I	flux density of direct solar radiation at ground level through a horizontal surface

I'	flux density of direct solar radiation at ground level through a surface at right angles to the solar rays
I_0	flux density of solar radiation outside the atmosphere through a surface at right angles to the solar rays
LAT	local apparent time
R	gas constant for air ($=287 Jkg^{-1}K^{-1}$)
$\tilde{R}$	global radiation at ground level / $I_0 \cos\theta$
R_i	fraction of constituent i above the 50kPa level
R_a	fraction of aerosol above the 50kPa level
R_w	fraction of water vapor above the 50kPa level
T	transmissivity of direct solar radiation in general
$\tilde{T}$	absolute station temperature
T_a	transmissivity of direct solar radiation due to aerosol extinction (=absorption+scattering)
T_{aa}	transmissivity of direct solar radiation due to aerosol absorption
T_{as}	transmissivity of direct solar radiation due to aerosol scattering
T_o	transmissivity of direct solar radiation due to ozone absorption
T_R	transmissivity of direct solar radiation due to Rayleigh scattering
T_w	transmissivity of direct solar radiation due to water vapor absorption

a	surface albedo
$\tilde{a}$	intercept of regression line
a_{ij}	matrix elements of the homogeneous system (eqns. 4.7,4.8)
a_o^{vis}	absorptivity of visible direct solar radiation due to ozone
a_o^{uv}	absorptivity of ultraviolet direct solar radiation due to ozone
a_w	absorptivity of direct solar radiation due to water vapor
$\tilde{b}$	slope of regression line
b_i	vector elements of the inhomogeneity (eqns.4.7,4.8)
d	number of day
$f(z)$	functional part of the inhomogeneity (eqns.4.7,4.8)
g	gravity acceleration ($=9.81ms^{-2}$)
h	hour angle
m	relative optical air mass
$m\uparrow$	diffusivity factor for upwelling diffuse radiation
$m\downarrow$	diffusivity factor for downwelling diffuse radiation
n	complex index of refraction
n_1	real part of the complex index of refraction

n_2	imaginary part of the complex index of refraction
p	station pressure
r	relative sun-earth distance
r_1, r_2	eigenvalues of the homogeneous system (equ.4.18)
r_p	station pressure / 101.3kPa
r_T	absolute station temperature / 273K
t	time
t_d	dewpoint temperature
u	ozone amount
w	precipitable water
z	vertical coordinate
α	albedo of the clear sky for upwelling global radiation
β	volume extinction coefficient in general
β_a	aerosol volume extinction coefficient (=absorption +scattering)
β_{aa}	aerosol volume absorption coefficient
β_{as}	aerosol volume scattering coefficient
$\beta_R, \beta_R^{\uparrow}, \beta_R^{\downarrow}$	Rayleigh volume scattering coefficients
$\beta_w, \beta_w^{\uparrow}, \beta_w^{\downarrow}$	water vapor volume absorption coefficients

δ	solar declination
θ	astronomical angle between the local zenith and the solar position
θ'	observed angle between the local zenith and the solar position
λ, λ_0	wavelength
φ	latitude
ρ	air density
τ	optical depth in general
τ_a	aerosol optical depth (due to absorption+scattering)
τ_{aa}	aerosol optical depth due to absorption
τ_{as}	aerosol optical depth due to scattering
τ_R	optical depth due to Rayleigh scattering
τ_w	optical depth due to water vapor absorption
ω_0	aerosol single-scattering albedo
$\omega_{0,cr}$	critical aerosol single-scattering albedo

1. Introduction

One of the threats facing mankind during the late twentieth century is inadvertent climatic change. It is believed to have its origin mainly in two processes: the increase of both carbon dioxide and aerosol concentration on a world-wide scale (Rasool and Schneider, 1971). Carbon dioxide is of crucial importance to the transfer of terrestrial radiation, while aerosol influences the solar spectrum.

Carbon dioxide concentration is known to be largely uniform in the atmosphere. This is not true for atmospheric aerosols which, due to their comparatively short residence times in the lower atmosphere, are concentrated in their natural and anthropogenic source areas.

Thus, until recently, remote areas were said to be subject to a background aerosol load (Porch and Radke, 1970) which reflects the equilibrium state between natural aerosol production and destruction. It was not before the early 1970s when measurements indicated that, even for a site as remote as northern Alaska, the atmospheric turbidity due to aerosol is, at least seasonally, comparable to non-urban points in midlatitudes (Shaw and Wendler, 1972; Radke et al., 1976). During the 1980s a multitude of research papers are revealing the spatial and seasonal patterns in the western Arctic and the chemical composition of the atmospheric particulates. The next chapter details the assumption that, in the western Arctic, the atmospheric turbidity due to aerosol, in short aerosol turbidity, undergoes an annual cycle with a marked maximum in winter and spring, and originates from the midlatitudes.

At the present stage of the discussion, the results are preliminary rather than definite. Porch and MacCracken (1982), for example, complain about 'the significant uncertainty in the optical constants of the arctic aerosol'. Therefore, more research is required into the areal extent as well as into the composition of the arctic aerosol. This is closely related to the question of the origin of the aerosol.

From the point of view of climatology, a period of at least several years has to be investigated to reach more general conclusions. This is only possible if use is made of data obtained on a routine basis. These data are usually not tailored for the use in studies focussed on a special topic but rather for a general climatological overview. Therefore, the possibilities of retrieving sophisticated results, especially in the field of chemical composition of aerosols, are inevitably limited.

The Atmospheric Environment Service, Canada, publishes hourly data sufficient to calculate the aerosol turbidity at about one dozen of arctic stations. For only one such station, Resolute (74.7°N, 95.0°W, see Figure 1) can the published data be used to calculate the single-scattering albedo, the interpretation of which allows conclusions as to whether the aerosol is heavily influenced by man-made

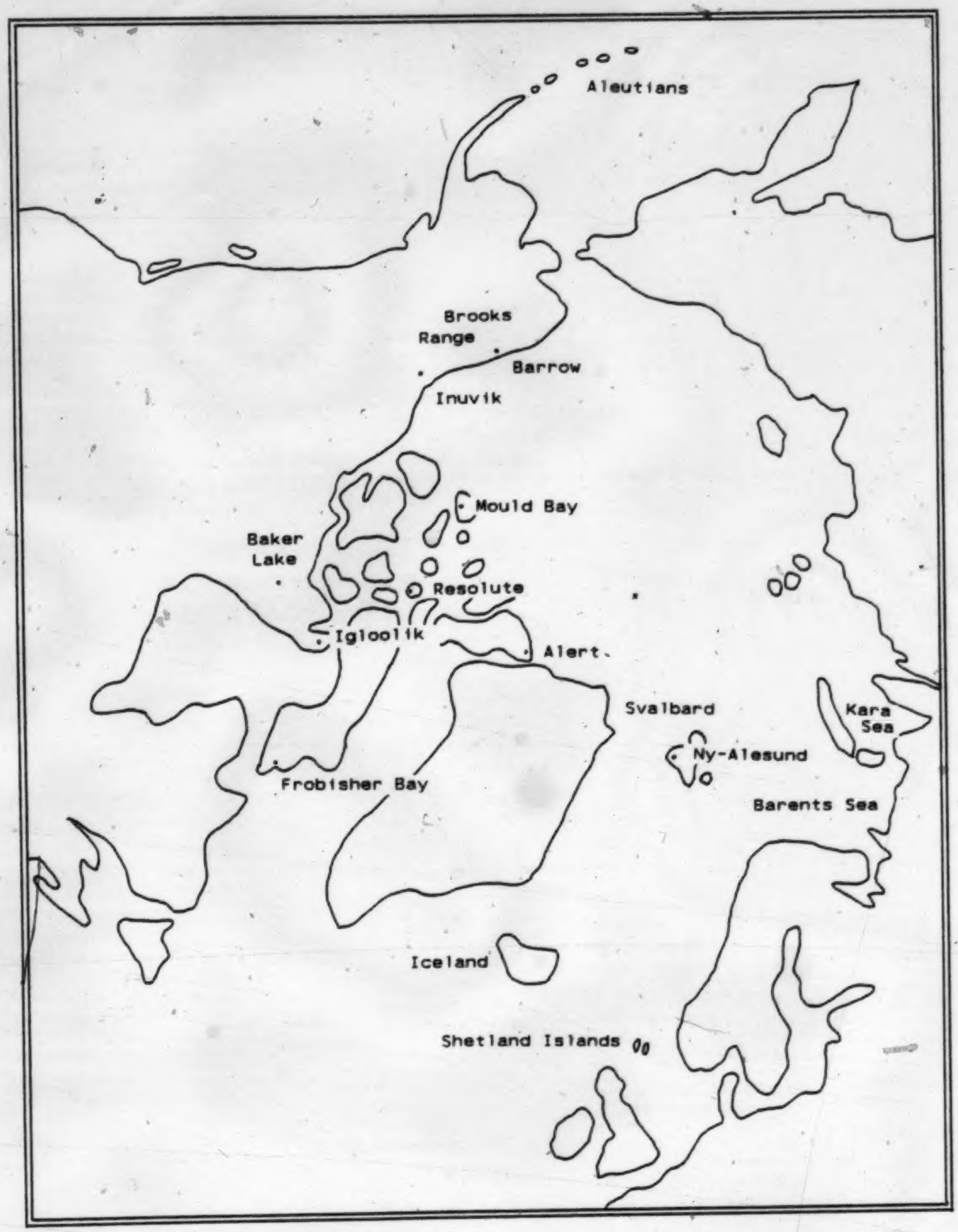

Aleutians
Brooks Range
Barrow
Inuvik
Mould Bay
Baker Lake
Resolute
Igloolik
Alert
Svalbard
Kara Sea
Ny-Alesund
Frobisher Bay
Barents Sea
Iceland
Shetland Islands

Figure 1: Location of some place names mentioned in this thesis

pollution.

The purpose of this thesis is to calculate for a three-year period (January 1978 to December 1980) on an hourly basis the aerosol optical depth for Resolute, Alert (82.5°N, 62.3°W), Inuvik (68.3°N, 133.5°W), Baker Lake (64.3°N, 96.0°W), and Frobisher Bay (63.7°N,68.6°W), and the single-scattering albedo for Resolute using various empirical and theoretical radiative transfer approaches.

2. Literature Review

Solar radiation data collected by the Atmospheric Environment Service consist of hourly global radiation readings covering the entire spectrum and, in the case of Resolute, of additional diffuse and reflected radiation readings of the entire spectrum. With these data only the aerosol optical depth can be calculated, which indicates the degree of turbidity of an atmosphere due to suspended particulate matter. For Resolute, the single-scattering albedo can be inferred from various radiation models. It indicates the contribution of aerosol absorption to aerosol attenuation. As natural aerosols are usually almost non-absorbing and man-made particulates may be highly absorbing, it can, as a first approach, be interpreted as a measure of the anthropogenic contribution to turbidity.

2.1 Aerosol optical depth

The attenuation of direct solar radiation can be described symbolically by

$$I = T_t I_0 \cos\theta \qquad (2.1)$$

where I_0 represents the unattenuated direct beam flux density (solar constant), I is the direct beam flux density on a horizontal surface at ground, θ is the solar zenith angle and T_t is the total transmissivity. In the solar spectrum, T_t can be approximated by

$$T_t = T_o T_R T_w T_a \tag{2.2}$$

with T_o being the transmissivity after ozone absorption, T_R the transmissivity after Rayleigh scattering, T_w the transmissivity after water vapor absorption and T_a the transmissivity after aerosol extinction.

The latter can be represented by

$$T_a = T_{aa} T_{as} \tag{2.3}$$

with T_{aa} being the transmissivity after aerosol absorption and T_{as} the transmissivity after aerosol scattering.

The transmissivities are usually written as

$$T_a = \exp(-\tau_a m) \tag{2.4}$$

$$T_{aa} = \exp(-\tau_{aa} m) \tag{2.5}$$

$$T_{as} = \exp(-\tau_{as} m) \tag{2.6}$$

where τ_a, τ_{aa} and τ_{as} are the aerosol optical depth, the aerosol optical depth due to absorption, and the aerosol optical depth due to scattering, respectively. m is the relative optical air mass which is approximately

$$m \doteq (\cos\theta)^{-1} \qquad (2.7)$$

As can be seen from equation 2.4, τ_a is independent of the solar position and is therefore an absolute measure of aerosol turbidity. Thus, it can be used for comparison between different locations and different seasons.

τ_a can only be measured if the solar disk is unobstructed by clouds. But in many instances, the aerosol turbidity at ground level has been measured with integrating nephelometers which use an artificial light source and a small sample air volume. (see e.g. Charlson et al., 1967). This device allows the direct measurement of the aerosol volume scattering coefficient β_{as} which is defined as

$$dI/I = -\beta_{as}dx \qquad (2.8)$$

where dI/I is the fraction of radiation scattered out of a beam by the aerosol on a light path of length dx. β_{as} is a function of the particle number-size distribution and therefore generally a function of space. Introducing z as the vertical coordinate in the atmosphere, the relation between τ_{as} and β_{as} is then

$$\tau_{as} = \int_0^\infty \beta_{as}(z)dz \qquad (2.9)$$

Aircraft measurements indicate that for the lower 5000m of the atmosphere $\beta_{as}(z)$ can be approximated by

$$\beta_{as}(z)=\beta_{as}(0)\exp(-z/H_a) \qquad (2.10)$$

with H_a being 1000m over central Europe (Penndorf, 1954), 1400m over Alaska (Shaw, 1975), and 2000m over Nebraska (Blifford and Ringer, 1969). For a model standard atmosphere, Elterman (1964) suggests 1200m. From equation 2.9 and 2.10 follows that

$$\tau_{as}=H_a\beta_{as}(0) \qquad (2.11)$$

or as a very first approximation

$$\tau_{as}=1200\beta_{as}(0) \qquad (2.12)$$

with $\beta_{as}(0)$ expressed in m^{-1}.

In Chapter 2.2 it will be shown that τ_{aa} is usually not negligible compared with τ_{as}. For very preliminary estimations it may be assumed that on the global average

$$\tau_{aa}\doteqdot 0.25\,\tau_{as} \qquad (2.13)$$

so that from equations 2.12 and 2.13:

$$\tau_a=\tau_{aa}+\tau_{as}=1500\beta_{as}(0) \qquad (2.14)$$

Table 1 presents an incomplete list of some measurements of τ_a for various regions of the world excluding the Arctic

Location	Time	τ_a	Reference	λ (µm)
western U.S.	winter;summer 1961-66	0.1;0.2	Flowers et al., 1969	0.5
eastern U.S.	winter;summer	0.2;0.5		
eastern U.S.	winter;summer 1972-75	0.2;0.5	Husar et al., 1981	0.5
New York City	Dec. 1967	(0.35)	Chin-I Lin et al., 1973	0.5
100km east of N.Y.C.	winter;summer 1975-76	(0.15);(0.15)	Brown and Sethu Raman, 1981	?
Lake Ontario	winter and summer, 1969, 72-73	0.1	Davies et al., 1975	e.s.s.
St. Louis	mainly summer 1974-76	0.25	Method and Carlson, 1982	e.s.s.
Ireland, W-coast	winter and summer 1966-70	0.2	Unsworth and Monteith, 1972	e.s.s.
Britain, rural sites		0.25		
Britain, urban sites		0.4		
Lagos, Nigeria	Nov. 1977-Feb. 1978 (dust storm period)	1.1	Oluwafemi, 1979	0.5
North Atlantic	May 1977	(0.02-0.3)	Fitzgerald, 1980	0.55
Antarctica	Nov. 1966-Jan. 1967	0.03-0.09	Fischer, 1967	0.5
Antarctica	summer 1974-79	0.015	Shaw, 1980a	0.5

e.s.s. = entire solar spectrum

Table 1: Aerosol optical depth τ_a for various regions of the world; except the Arctic. Values in brackets were calculated from aerosol volume scattering coefficients using equation 2.14.

made during the last few years. Values in brackets indicate calculations made from $\beta_{as}(0)$-readings of integrating nephelometers using equation 2.14.

At this juncture it has to be pointed out that τ_{as} and β_{as} are also functions of wavelength

$$\frac{\tau_{as}(\lambda)}{\tau_{as}(\lambda_0)} = \frac{\beta_{as}(\lambda)}{\beta_{as}(\lambda_0)} = \left(\frac{\lambda_0}{\lambda}\right)^{\alpha} \qquad (2.15)$$

Ångström (1961) found that the wavelength exponent, α, is 1.3±0.2 but may be as low as 0.5 after volcanic eruptions and forest fires (see, e.g., Ryznar et al., 1981). Many subsequent studies confirmed Ångström's findings.

Unfortunately, τ_a and $\beta_{as}(0)$ are sometimes being determined for $\lambda = 0.5 \mu m$ and sometimes for the entire solar spectrum. For Table 1, no attempts have been made to calculate τ_a for the entire solar spectrum from the values given for $\lambda = 0.5 \mu m$. But with regard to the uncertain assumptions made so far, measurements made at around $0.5 \mu m$ may be taken to be similar to those for the entire solar spectrum.

Table 2 presents various values of τ_a for Barrow, Alaska, and Table 3 for other stations in the western Arctic. Values in brackets are again estimated from integrating nephelometer measurements of the scattering coefficient at ground level, $\beta_{as}(0)$, using equation 2.14. It is obvious that the values in brackets are approximately by a factor of 3 lower than the values gained from direct

Barrow, Alaska (71.3°N, 156.6°W)			
Time	τ_a	λ(μm)	Reference
Mar. 1970	(0.05–0.09)	0.49	Radke et al., 1976
Apr. 1972	0.28 - 0.39	0.5	Shaw, 1975
Jul. 1972	0.05 - 0.22		
Jan.–Mar.	(0.02) southerly winds	0.55	Peterson et al., 1980
1977–78	(0.05) northerly winds		
1977; 1978:		0.55	Bodhaine et al., 1981
Jan.	(0.02)		
Feb.	(0.04);(0.02)		
Mar.	(0.02);(0.02)		
Apr.	(0.02);(0.02)		
May	(0.01)		
Jun.	(0.002);(0.003)		
Jul.	(0.009)		
Aug.	(0.006);(0.005)		
Sep.	(0.004);(0.004)		
Oct.	(0.008);(0.006)		
Nov.	(0.01);(0.01)		
Dec.	(0.1);(0.009)		
19??		0.5	Shaw, 1981
Mar.	0.1 –0.2		
Apr.	0.1 –0.2		
Jun.	0.05–0.1		
Jul.	0.02–0.05		
Oct.	0.02–0.04		

Table 2: Aerosol optical depth τ_a for Barrow, Alaska. Values in brackets were calculated from aerosol scattering coefficients using equation 2.14.

Brooks Range, Alaska (69.3°N, 143.8°W), elevation 1740m

Time	τ_a	λ(μm)	Reference
1970–71:		0.58	Shaw and Wendler, 1972
1st half May	0.14*		
2nd half Jun.	0.06*		
2nd half Jul.	0.05*		

Mould Bay, Canada (76.2°N, 119.3°W)

Time	τ_a	λ(μm)	Reference
1979;1980:		?	Barrie et al., 1981
Jan.	(0.05)		
Feb.	(0.06)		
Apr.	(0.03);(0.04)		
May	(0.02);(0.03)		
Jun.	(0.005)		
Jul.	(0.003)		
Aug.	(0.005)		
Sep.	(0.01)		
Oct.	(0.02)		
Nov.	(0.02)		
Dec.	(0.04)		

continued on next page

Igloolik, Canada (69.4°N, 81.8°W)			
Time	τ_a	λ (μm)	Reference
Nov. 1979	(0.01)	?	Barrie et al., 1981
Dec. 1979	(0.02)		
Jan. 1980	(0.03)		
Feb. 1980	(0.04)		
Mar. 1980	(0.04)		
Apr. 1980	(0.03)		
May 1980	(0.03)		
Ny–Ålesund, Svalbard (79°N, 12°E)			
Time	τ_a	λ (μm)	Reference
Apr.,May 1979	(0.02)	0.55	Heintzenberg, 1980

Table 3: Aerosol optical depth τ_a for various arctic stations, except Barrow, Alaska. Values in brackets were calculated from aerosol scattering coefficients using equation 2.14. The asterisk indicates values which had to be calculated from Ångström turbidity coefficients (Ångström, 1961) assuming a wavelength exponent of 1.3

observations of the direct component of the solar radiation flux density. But for other regions of the world (Table 1) the values in brackets seem to be compatible with the direct measurements of τ_a.

Therefore, it must be concluded that equation 2.14 is not applicable for arctic stations. This is surprising because equation 2.10 was found to be correct for Barrow, Alaska, with a scale height H_a of 1400m, as mentioned before. Also, the errors incurred by the use of equation 2.13 can certainly not explain the difference. Chapter 4 will give as possible explanation that the scale height H_a is, contrary to the findings of Shaw (1975), probably several times greater.

Thus, integrating nephelometer measurements cannot be used to determine the aerosol optical depth in the Arctic. But only the aerosol optical depth can be used as a measure of the aerosol turbidity of the entire atmosphere, because determination of the aerosol optical depth is an automatic integration of the local turbidity parameter $\beta_{as}(z)$ from the bottom to the top of the atmosphere, as can be seen from equation 2.9.

Comparison of Tables 2 and 3 with Table 1 reveals two striking features: Firstly, the average optical depth in the Arctic is distinctly below the average of the midlatitudes. This statement is based on the interpretation of the directly measured aerosol optical depths (values without brackets). Secondly, there is a marked seasonal march of the aerosol optical depth, with the lowest values in summer, a continuous increase in fall and winter, and a maximum in spring. A dramatic decrease between May and June is the most characteristic feature of the seasonal pattern.

The seasonal turbidity pattern is not identical every year, as can be seen from the extreme difference at Barrow between December 1977 and December 1978. Differences on a day-to-day basis seem to be attributable to different air masses, as can be seen from aerosol turbidity differences between days with southerly and northerly winds at Barrow in winter. Similar observations were made by Unsworth and Monteith (1972) for the British Isles and by Fitzgerald (1980) on a voyage across the North Atlantic.

2.2 Single-scattering albedo

The single-scattering albedo ω_0 for an aerosol is defined by

$$\omega_0 = \frac{\beta_{as}}{\beta_{as} + \beta_{aa}} \qquad (2.16)$$

with the aerosol volume scattering coefficient, β_{as}, as defined in equation 2.8, and the aerosol volume absorption coefficient, β_{aa}, defined in an analogous manner.

In many instances, however, not the single-scattering albedo ω_0 but the imaginary part n_2 of the complex index of refraction

$$n=n_1-in_2 \tag{2.17}$$

is being determined by laboratory experiments with collected aerosols.

A functional relationship between n_2 and ω_0 can be found for a given aerosol number-size distribution, a given real part n_1 of the complex refractive index of the aerosol, and a given wavelength λ.

The derivation of this functional relationship necessitates a complete solution of the Mie scattering problem. Besides the approach by Hansen and Travis (1974), only Twomey (1977) has calculated this relationship for a Junge distribution of particles between 0.01 and 10μm, with a real part of $n_1=1.5$ at $\lambda=0.55\mu m$. The relationship is shown in Figure 2. Twitty and Weinman (1980) calculated ω_0 at $\lambda=0.5\mu m$ for carbonaceous material ($n=1.8-0.5i$) and two non-Junge size distributions which are supposedly representative of urban aerosols.

Simultaneous measurements of ω_0 and n_2 were only reported by Chin-I Lin et al. (1973) for the New York City aerosol and by Roessler and Faxvog (1979) for acetylene soot produced in the laboratory. These latter measurements indicate that Twomey's calculations can be used to estimate ω_0 from n_2 with an error of less than 0.1. In fact, Junge aerosol number-size distributions have been found to be good approximations for many locations (cf. recent findings for Denver (Willeke and Whitby, 1975) and Mildura, Australia

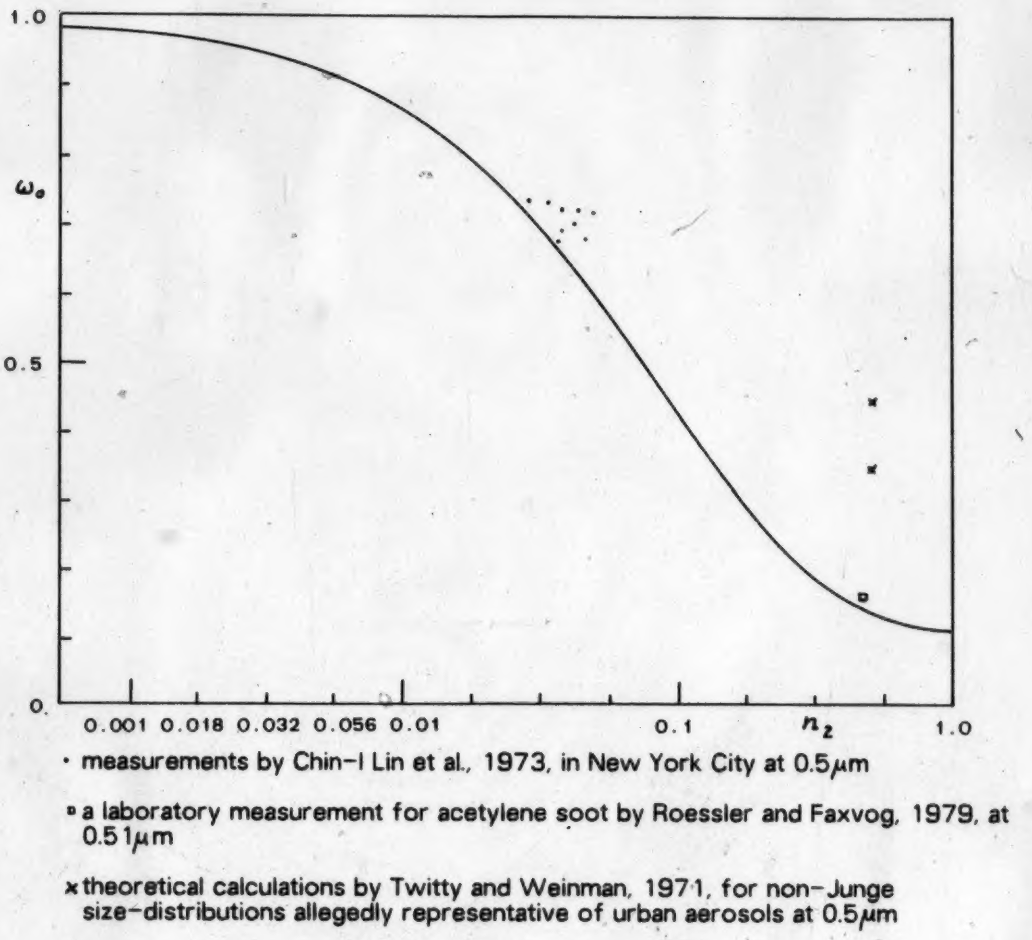


Figure 2: Single-scattering albedo ω_0 as a function of the imaginary part of the complex refractive index n_2 for a Junge distribution of particles between 0.01 and 10μm with a real part of the refractive index of 1.5 and for $\lambda = 0.55\mu m$ (after Twomey, 1977, p.226).

(Gras and Michael, 1979)).

Table 4 presents values for the single-scattering albedo ω_0 for various aerosol substances. Table 5 presents ω_0-values for atmospheric aerosol samples taken at various locations. In Tables 4 and 5, values in brackets indicate calculations from n_2 -measurements using Twomey's relationship (Figure 2). They have to be treated with care. Measurements were being made at different wavelengths. But, as can be seen from Twitty and Weinman (1971), the single-scattering albedos for two different non-Junge size distributions are only slightly dependent on wavelength for $\lambda < 3\mu m$.

It is obvious from Table 4 that the dominant natural aerosols, viz. sulfates, sea salts, and crustal particles, all have single-scattering albedos close to unity. On the other hand, products of combustion show very low single-scattering albedos around 0.10 to 0.15. In other words, products of combustion are highly absorbing, whereas natural aerosols are almost pure scatterers. Sadler and Charlson (1981) found a high correlation between the aerosol volume absorption coefficient β_{aa} and the carbon content of an aerosol in Washington state.

But, with the exception of forest fires, products of combustion are almost exclusively man-made. Thus, the single-scattering albedo should be a tool to determine to what degree an aerosol is influenced by man's activities.

Aerosol substance	ω_o	$\lambda(\mu m)$	Reference
sulfates	0.999	2	Toon and Pollack, 1976
NaCl	0.999	visible	
basalt	0.98-0.96	visible	
propane soot	(0.17-0.13)	0.51	Roessler and Faxvog, 1980a
acetylene soot, diesel exhaust	0.16	0.51	Roessler and Faxvog, 1979, 1980a, 1980b, 1981
carbon particles	(0.12)	0.55	Bergstrom, 1973a
graphite	(0.12)	0.51	Roessler and Faxvog, 1980a
carbon black	(0.12)	0.51	

Table 4: Single scattering albedos ω_o for various aerosol substances. Values in brackets are calculated from measurements of the imaginary part of the refractive index using the functional relation of Figure 2.

Location	ω_0	λ (μm)	Reference
U.S.:			
7 urban-industrial sites	0.50–0.65	0.54	Waggoner et al., 1981
7 urban-residential sites	0.73–0.87		
3 remote sites	0.91–0.94		
New York City	0.68–0.74	0.5	Chin-I Lin et al., 1973
St. Louis	0.89	e.s.s.	Method and Carlson, 1982
fly ash from forest fires in the U.S.	(0.60)	0.69	Grams et al., 1972
Tucson, Arizona	(0.70)	0.52	King, 1979
Big Spring, Texas	(0.90)	0.5	Grams et al., 1974
Big Spring, Tex., and Blythe, Cal.	(0.90)	0.5	DeLuisi et al., 1976
desert of southern New Mexico	(0.90)	0.6	Lindberg and Laude, 1974 Lindberg, 1975
Gainesville, Florida	(0.90)	e.s.s.	Ward et al., 1973
southern England	0.80	e.s.s.	Roach, 1961
Shetland Islands, Great Britain	0.59	e.s.s.	Forbes and Hamilton, 1971
Irish west coast	(0.90)–(0.95)	0.6	Fischer, 1973
Jungfraujoch (3560m), (Switzerland)	(0.85)		
industr. aerosols, Germany	(0.65)–(0.85)	0.5	Fischer, 1970
Mainz, Germany	(0.45)–(0.85)	0.55	Eiden, 1966
Mainz, Germany	(0.65)	0.6	Fischer, 1973
North Atlantic:			
Saharan dust	0.71	0.47	Carlson and Caverly, 1977
Saharan dust	(0.85)	0.5	Patterson et al., 1977
sea salt aerosol	(1.00)		
'bush', near Tsumeb, Namibia	(0.65)	0.6	Fischer, 1973
Tel Aviv, Israel	(0.40)	0.5	Levin et al., 1979
Negev desert, Israel	(0.70)	0.5	
desert of Iran and Pakistan	(0.95)–(1.00)	0.5–1.1	Otterman et al., 1982

Table 5: Single scattering albedos ω_0 for various locations . Values in brackets are calculated from measurements of the imaginary part of the refractive index using the functional relationship of Figure 2 and rounded off to the nearest multiple of 0.05. e.s.s. means the entire solar spectrum.

Table 5 shows that this prediction holds approximately. The lowest values of ω_0 that have been measured are around 0.40 to 0.65 and can be found near to urban-industrial sites. At urban-residential sites and cities without major pollution sources ω_0 may be expected to range between 0.75 and 0.90. Values around 0.85 to 0.90 are already typical for rather remote sites. But single-scattering albedos above 0.90 can mainly be found in pollution-free and mainly maritime air masses, e.g., on the western coast of Ireland.

Some values from Table 5 need a comment: The forest fire fly ashes show values as low as 0.60, hence they are indistinguishable from man-made combustion products at heavily polluted sites. The value of 0.59 for the Shetland Islands, if reliable, indicates that single-scattering albedos typical of heavy pollution can, in fact, be found at a distance as far as 1000km from the major pollution sources. The low value of 0.65 in the semi-desert near Tsumeb, Namibia, was measured during the dry season and is due to organic matter, viz. dry grass, being ground by wind erosion to aerosol-sized remnants and lifted into the air (Fischer, 1973). This organic material, although not burnt, behaves optically like ashes. This may also be an explanation for the low single-scattering albedos measured at other desert locations.

It should be pointed out that neither direct nor indirect measurements of the single-scattering albedo are available for any arctic station.

The single-scattering albedo is a quantity of crucial importance in global climatic studies. Until about twenty years ago, it has been tacitly assumed that aerosols are virtually non-absorbing, and hence the single-scattering albedos are close to unity.

It was not before the sixties when Roach (1961), Robinson (1962,1966), McCormick and Ludwig (1967), and Charlson and Pilat (1969) drew attention to the absorbing nature of aerosols. In the case of aerosols which both scatter and absorb, any increase of the total load also results in an increase of absorption in the atmosphere.

Several subsequent studies investigated whether a higher aerosol load leads to falling or rising temperatures of the surface-atmosphere system in the case of a cloudless atmosphere without heat advection:

From the model given by Ensor et al. (1971) a critical single-scattering albedo $\omega_{o,cr}$ can be calculated which is a function of the surface albedo, a, and of the ratio of aerosol backscattering to total scattering which is a function of the solar zenith angle. This ratio will be dealt with in detail in Chapter 4.

If the single-scattering albedo of the aerosol ω_o exceeds $\omega_{o,cr}$, an increasing aerosol concentration entails falling temperatures of the surface-atmosphere system and vice versa. For a solar zenith angle of approximately 70° and surface albedos of 0.2 and 0.8, respectively, the results for $\omega_{o,cr}$ are:

$$\omega_{o,cr} = \begin{cases} 0.50 & \text{for } a=0.2 \\ 0.94 & \text{for } a=0.8 \end{cases} \qquad (2.18)$$

Atwater (1970), in a similar approach, comes up with a result from which follows that $\omega_{o,cr}$ is also a function of the ratio, $\tilde{R}$, of global radiation at the ground to global radiation at the top of the atmosphere. Therefore, for a given solar zenith angle (e.g. 70°), and given combinations of a and $\tilde{R}$ (e.g., at Resolute, typical values for cloudless hours are: $a=0.2$ together with $\tilde{R}=0.7$, and $a=0.8$ together with $\tilde{R}=0.8$, each for zenith angles of $\theta=70°$) $\omega_{o,cr}$ can be calculated to be

$$\omega_{o,cr} = \begin{cases} 0.67 & \text{for } a=0.2 \\ 1.08 & \text{for } a=0.8 \end{cases} \qquad (2.19)$$

As, by definition, $0 \leq \omega_o \leq 1$, the very last result means that any aerosol increase leads to a warming of the surface-atmosphere system. It turns out that the value for $\omega_{o,cr}$ from equation 2.19 becomes identical with the value for $\omega_{o,cr}$ from equation 2.18 for the rather unrealistic assumption of $\tilde{R} \to 0$, i.e., an atmosphere of infinite optical thickness.

Coakley and Chýlek (1975) present a result which can be found to be also a function of $\tilde{R}$ and which is exactly correct only for $\tilde{R} \to 1$, i.e., a completely transparent atmosphere.

From Twomey (1977,p.285f.) a critical single-scattering albedo can be found which is independent of $\tilde{R}$. For a solar zenith angle of 70° and albedos of 0.25 and 0.75, respectively, the following holds:

$$\omega_{o,cr} = \begin{cases} 0.80 & \text{for } a=0.25 \\ 0.99 & \text{for } a=0.75 \end{cases} \qquad (2.20)$$

Yamamoto and Tanaka (1972) find that an imaginary part of the refractive index of 0.05 (corresponding to ω_o=0.6, according to Figure 2) is approximately the critical value for low albedos (0.05-0.15) and various zenith angles.

In a very extensive study containing a complete solution to the radiation transfer problem, Herman and Browning (1975) presented a result indicating that, when a=0.8, warming occurs in any case, whereas for a=0.1 and a solar zenith angle of 55° the critical imaginary part is 0.018 (corresponding to ω_o=0.79).

There are several more attempts to solve the problem of climatic change with increasing aerosol load. But the results of these studies are not reliable because important terms were forgotten right at the outset of the calculations: Mitchell (1971), Rasool and Schneider (1971), Chýlek and Coakley (1974), and Russell and Grams (1975) all forgot to take Rayleigh scattering into account. This is under no circumstances justifiable, as Rayleigh scattering is usually at least of the same order of magnitude as aerosol attenuation. Neumann and Cohen (1972) do not consider reflection of global radiation from the ground; thus their model is not applicable for snow covered surfaces. Finally, Barrett (1971) assumes that aerosols are not absorbing, which is an invalid approach.

So, it can be concluded that, for the high albedos typical for arctic snowfields, the addition of almost any aerosol leads to a warming of the surface-atmosphere system, whereas for the low albedos of the tundra in summer this question cannot be answered unambiguously.

A more detailed study of the influence of aerosol on the terrestrial and atmospheric temperatures, specifically for an arctic environment, was made by Shaw and Stamnes (1980). It concludes that, after a layer of aerosol with typical values for τ_a and ω_0 is introduced into the model atmosphere, the shortwave radiation balance is altered such that the atmosphere is being heated and the surface being cooled. The longwave radiation balance is not affected. In a very similar study, Grondin (1980) confirms these results.

2.3 Origin of the arctic aerosol

The extent and seasonal variation of the arctic aerosol turbidity was depicted in Section 2.1. This section tries to elucidate the question of its origin. This question has a political dimension because statements about the sources are automatically statements about the 'responsibility' for the so-called 'arctic haze'.

At first, arctic aerosol turbidity was thought to be an autochthonous phenomenon due to ice crystal formation at very low temperatures (Shaw, 1975). But, shortly thereafter, Rahn et al. (1977) discovered from chemical analysis that true aerosol layers are responsible for occasionally high turbidities.

A relatively simple but still powerful tool to determine whether an aerosol is mainly composed of the materials of the earth's crust, or is composed of sea salt or is of a different composition, is the enrichment factor. For crustal material, the enrichment factor E_x with respect to any element X is defined by

$$E_x = \frac{(X/Al)_{aerosol}}{(X/Al)_{crust}} \tag{2.21}$$

where X means the mass of an element X and Al the mass of aluminum for the aerosol sample and for the average of the earth's crust, respectively. The closer E_x approaches unity the more reliable is the statement that an aerosol sample is made up of crustal material. For sea salt the enrichment factor is defined similarly.

Using equation 2.21 Rahn et al. (1977) found that the events of high aerosol turbidity at Barrow in spring are probably due to a crustal aerosol.

In a later study Rahn (1981b) defined the noncrustal concentration of an element X in an aerosol by

$$X_{aer,noncr}=X_{aer,total}-(X/Al)_{crust}\,Al_{aer} \qquad (2.22)$$

With vanadium and manganese as elements X, appreciable noncrustal concentrations were found in the Arctic for winter (Rahn and McCaffrey, 1980). Noncrustal vanadium stems from combustion of residual oil, whereas noncrustal manganese has various sources.

Now a ratio Y can be defined by

$$Y=Mn_{aer,noncr}/V_{aer,noncr} \qquad (2.23)$$

Y was found to be 2.0 for Eurasian aerosols, but 0.4 for North American aerosols. For the Arctic, Y-values greater than 1.0, sometimes even as high as 2.0, were reported. With regard to the fact that Y decreases with increasing age of an aerosol, Rahn (1981b) concludes that the arctic aerosol originates in Eurasia rather than in North America.

Rahn and Heidam (1981) in a general review on arctic air chemistry between 1977 and 1980 report that graphitic carbon was found 'in abundance'. Rosen et al. (1981) prove the existence of graphite by Raman spectroscopy and by determining the wavelength dependence of absorptivity, as well as the solubility and oxidation temperature of collected aerosol samples. This finding, together with the finding that the aerosol size spectrum is typical of highly aged aerosols, is one more indication that the arctic aerosol is a pollution-derived aerosol from a distant source, at least during the periods of high turbidity.

From measurements made at Barrow in 1979 Daisey et al. (1981) report that particulate organic matter is in March, four times as abundant as in August; the aerosol is reported as being dominated by fly ash in March and pollen as well as sea salt in August. But Barrie et al. (1981) in a study made on aerosol samples taken at Mould Bay (76.2°N, 119.3°W) and Igloolik (69.4°N, 81.8°W) conclude that the pollen originate exclusively in North American deciduous forests. This is not only true for September and October, but also for April and May which is the season with the heaviest turbidity. Thus, North America has to be considered as a possible source region, too.

A different approach to this problem is the synoptical one (Rahn, 1981a): The flow pattern in the Arctic in winter is generally determined by the Siberian high, the Icelandic low, and the Aleutian low. Therefore, there are two major pathways for midlatitudinal air to the North American Arctic: from Europe, cutting across the Arctic Ocean somewhere between the North Pole and the northern coast of Asia, reaching Alaska and northern Canada as a northerly or northwesterly wind, and from eastern Asia across the Pacific Ocean and along the Canadian west coast, reaching Alaska as a southerly wind. Air from eastern North America could reach the Arctic only via Europe.

But these pathways are not equivalent in their efficacy for bringing high pollution loads to the Arctic. This is so because precipitation is the controlling factor for aerosol residence times, due to the processes of rain-out and wash-out. Both trajectories, from eastern Asia to Alaska, and from eastern North America to Europe, go over stormy and rainy seas. But the trajectory from Europe via the Arctic Ocean is a cold one with no major precipitation (Rahn, 1981a). Remembering that northerly winds bring greater turbidity to Barrow in winter than do southerly winds (Peterson et al., 1980) the synoptic situation supports the hypothesis of Europe as the pollution source.

In summer, these flow patterns do not exist, and the air in the Arctic is 'decoupled' (Rahn and McCaffrey, 1980) from midlatitudinal air masses through the polar front. Simultaneously, precipitation reaches its maximum, and so do the scavenging processes. This may explain the marked seasonal march of arctic aerosol turbidity.

Another approach to the problem of the origin of high aerosol turbidity is the reconstruction of actual trajectories on a given pressure surface. Rahn et al. (1977) by calculating back-trajectories on the 70KPa surface from Barrow, Alaska, for April and May 1976, arrive at the conclusion that, at least in spring, direct connections exist between high turbidity in northern Alaska and flows from the central Asian deserts of Takla Makan and Gobi to

Alaska.

Heavy soil dust loads with origin in eastern central Asia have also been found at Enewetak Atoll (11°N, 162°E) in April 1979 by Duce et al. (1980) and on Hawaii (19°N, 156°W) from late April to early May 1979 by Shaw (1980b) and Darzi and Winchester (1982). Duce et al. assert that 'in China dust storm activity is greatest in the spring because of the combined effects of low rainfall, the increased occurence of high surface winds which are associated with cold fronts, and soil freshly plowed for planting'.

In this context, it should be remembered that the maxima of turbidity in the Arctic occur in spring at about the same time when the central Asian dust storm activity occurs. The transarctic flow pattern from Europe to Alaska mentioned above can certainly not explain such a maximum.

More trajectory analyses were performed on the 85kPa level for Mould Bay from December 1979 to January 1980 (Barrie et al., 1981) and for Barrow from February 1975 to January 1980 (Miller, 1981). At Mould Bay, 50% of the 10-day back trajectories originated in polar regions, the remaining 50% came from Siberia, Europe, and North America. At Barrow, 60% of the 5-day back trajectories had their origins inside a circle of 2000km radius around Barrow, with a lower percentage in winter and a higher percentage in summer. For the trajectories from outside the 2000km radius there were two distinct source areas: the northern Pacific (southerly winds at Barrow), and the Kara- and Barents-Seas (northerly winds at Barrow). The north Pacific flow has a maximum in January and a minimum in June, with a secondary August maximum. The Eurasian flow is steady between July and March, and has a distinct minimum between April and June.

At this stage, no conclusion can be drawn as to the origin of high turbidities in the North American Arctic. There are three possible source areas: Europe, North America, and China. Evidence is available in favour of each of them. Unfortunately, almost all investigations have been concentrated on Barrow, Alaska. Investigations from Svalbard (79° N,12° E)(Heintzenberg, 1980; Heintzenberg et al., 1981) are so far not comprehensive. With the exception of a study by Polavarapu (1978) which yields doubtful results, only one investigation on arctic turbidity has so far been done in the vast territories of the Canadian Arctic (Barrie et al., 1981).

The purpose of this thesis is to fill some of this gap with investigations on the aerosol optical depth at five locations and the single-scattering albedo at one location in the Canadian Arctic. This is a necessary contribution to the knowledge of the spatial and seasonal patterns of the occurence of aerosol turbidity. Thus, it may be helpful for answering the question of its origin.

3. Aerosol optical depth at Resolute

3.1 Direct solar radiation model

In Chapter 2.1 the simplest model for the transfer of direct solar radiation was introduced (see equations 2.1 and 2.2):

$$I = T_O T_R T_W T_a I_o \cos\theta \qquad (3.1)$$

or abbreviated

$$I = \prod_{i=1}^{4} T_i I_o \cos\theta \qquad (3.2)$$

This multiplicative approach is, strictly speaking, only applicable if all transmissivities are independent of wavelength. This is certainly not true for the transfer of solar radiation in the earth's atmosphere, as ozone absorption can almost only be found in the ultraviolet spectral region, whereas water vapor absorption is restricted to the near infrared region. Rayleigh scattering obeys the well-known λ^{-4}-law, so its main contribution stems from short wavelengths. Even aerosol extinction is not wavelength independent: aerosol scattering was reported to obey approximately a $\lambda^{-1.3}$-law. The wavelength dependence of aerosol absorption is dependent on the aerosol material.

If the solar spectrum is divided into two equal parts at $\lambda=0.73\mu m$ (Coulson, 1975, p.315), it can be assumed that ozone absorption and Rayleigh scattering is confined to the lower part of the spectrum, and water vapor absorption occurs only in the upper part thereof. Aerosol extinction is assumed to be equally distributed over the entire spectrum.

Then, according to Paltridge and Platt (1976, p.121), equation 3.1 has to be written as

$$I=(T_0 T_R - a_w) T_a I_0 \cos\theta \qquad (3.3)$$

where a_w is the water vapor absorptivity, which is related to water vapor transmissivity T_w by

$$a_w = 1 - T_w \qquad (3.4)$$

This can be explained with an example:
Imagine $T_0 T_R = 0.85$ (or: $1-T_0 T_R = 0.15$), $T_w = 0.75$ (or: $a_w = 0.25$), and T_a = 1.00. As extinction due to ozone absorption and Rayleigh scattering is supposed to be confined to the lower 50% of the spectrum and water vapor absorption to the upper 50% thereof, 30% (or: 2*0.15) of the lower half and 50% (or: 2*0.25) of the upper half of the spectrum is subject to extinction, i.e., 40% of the entire spectrum is extinguished, in other words, the total transmissivity is 60%. Using the multiplicative approach (equation 3.1) would yield a total transmissivity of 0.85*0.75*1.00 = 0.64. But

equation 3.3 yields the correct solution: (0.85-0.25)*1.00 = 0.60.

Remembering that the aerosol transmissivity T_a can be expressed as

$$T_a = \exp(-\tau_a m) \qquad (3.5)$$

equation 3.3 can be solved for the aerosol optical depth :

$$\tau_a = -\frac{1}{m} \ln\left(\frac{I}{(T_o T_R - a_w) I_o \cos\theta}\right) \qquad (3.6)$$

This is the basic formula for calculating the aerosol optical depth from observations of direct solar radiation. This direct radiation model and the evaluation of its terms as described in the next section can be found in Davies and Hay (1980).

3.2 Evaluation of the model

To evaluate equation 3.6 seven quantities have to be known:

- the solar radiation flux density outside the atmosphere I_o;
- the direct horizontal solar radiation flux density on the ground I;
- the solar zenith angle θ;
- the optical air mass m;
- the ozone transmissivity T_o;

-the Rayleigh transmissivity T_R;
-the water vapor absorptivity a_w.

3.2.1 Solar radiation flux density outside the atmosphere

The solar constant or solar radiation flux density outside the earth's atmosphere at mean sun-earth distance is widely believed to be $1353 \pm 14 Wm^{-2}$ (ThekaeKara and Drummond, 1971). This value is referenced to the International Pyrheliometric Scale (IPS 1956) (see e.g. Latimer, 1973, and ThekaeKara, 1976).

Recently, Jacobowitz et al. (1979) suggested $1368 Wm^{-2}$ based on Nimbus 6 satellite measurements. However, this value is referenced to a new cavity radiometer scale which is approximately 2% higher than the older IPS 1956 and has not yet found international recognition. As the measurements used for this thesis are referenced to IPS 1956 (Canada, Environment Canada etc., 1978ff.) the new value would have to be lowered by 2% to $1341 Wm^{-2}$ and would therefore be inside the error limits given by ThekaeKara and Drummond (1971). Due to the uncertainties accompanied with the new scale, the old value of $1353 Wm^{-2}$ is being used throughout this thesis.

The variable relative sun-earth distance, r, must be accounted for by multiplying the solar constant with a factor $1/r^2$ to obtain the solar radiation flux density outside the atmosphere I_0. Spencer (1971) calculated this factor as being

$$1/r^2=1.000110+0.034221\cos\vartheta+0.001280\sin\vartheta+$$
$$0.000719\cos2\vartheta+0.000077\sin2\vartheta \quad (3.7)$$

with

$$\vartheta=2\pi d/365 \quad (3.8)$$

where d is the number of the day starting with d=0 on January 1st and going to d=364 on December 31st.

3.2.2 Direct solar radiation flux density on the ground

Direct horizontal solar radiation is not being measured at any site in the Canadian Arctic. But at one arctic location, namely Resolute, two pyranometers are working simultaneously: One measures global radiation from the entire celestial dome, and the other measures diffuse sky radiation. This is achieved by shadow bands mounted in such a way that the solar disk is obstructed. By subtraction of the two values direct solar radiation can be calculated. All pyranometers used in the Canadian Arctic are Eppley precision spectral pyranometers (PSP) (Latimer, 1980).

Canadian measurements are published as hourly radiation flux density values starting at each full hour local apparent time (LAT) given in the units $MJ/(m^2hour)$.

According to Latimer (1980), the root mean square (RMS) error of radiation readings is of the order of ±5%. Under the best conditions it may be as low as ±2%.

The implied error in τ_a caused by the 1% inaccuracy of I_0 and the 5% inaccuracy of I will be discussed in detail later.

3.2.3 Solar zenith angle

The solar zenith angle θ can be calculated from the well-known relation (see, e.g., Kondratyev, 1969, p.342, or Liou, 1980, p.46):

$$\cos\theta=\sin(\varphi)\sin(\delta)+\cos(\varphi)\cos(\delta)\cos(h) \qquad (3.9)$$

where φ is the latitude, δ the solar declination, and h the hour angle.

The declination can be expressed according to Spencer (1971) by

$$\delta=0.006918-0.399912\cos\vartheta+0.070257\sin\vartheta-0.006758\cos2\vartheta+ \\ 0.000907\sin2\vartheta-0.002697\cos3\vartheta+0.001480\sin3\vartheta \qquad (3.10)$$

with ϑ as defined in equation 3.8.

The hour angle h in degrees can easily be calculated from

$$h=15*|12-LAT| \qquad (3.11)$$

where LAT means the local apparent time in hours.

In reality, the sun appears to be closer to the zenith than predicted from equation 3.9. This is due to the refraction in the atmosphere. If θ denotes the astronomical zenith angle (equation 3.9) and θ' denotes the zenith angle observed with refraction, the difference $\theta-\theta'$ can be written as (Cameron et al., 1963):

$$\theta-\theta'=r_T^{i/2}\sum_{i=0}^{4} B_i(\theta)(r_P/r_T)^{i+1} \tag{3.12}$$

with r_T being the absolute station temperature divided by 273K, r_P being the station pressure divided by 101.3kPa, and $B_i(\theta)$ being coefficients tabulated by Garfinkel (1944).

The first and second columns of Table 6 present the ratio of the cosines of the real (θ') and astronomical (θ) zenith angles. For zenith angles of approximately 65° the difference is 1% and for zenith angles of approximately 85° the difference is as high as 10%. The error in τ_a incurred by neglecting refraction can be calculated from equation 3.6:

$$\Delta\tau_a=\frac{\partial\tau_a}{\partial\cos\theta}\,\Delta\cos\theta=\frac{1}{m\cos\theta}(\cos\theta'-\cos\theta) \tag{3.13}$$

The third and forth columns of Table 6 present the absolute changes in τ_a incurred by including refraction. The changes increase with increasing zenith angle and are about $\Delta\tau_a=\pm0.01$ at 85°. Because great zenith angles are quite common in the Arctic and the absolute values of τ_a are, at

θ	Z(273K)	Z(243K)	$\Delta\tau_a$(273K)	$\Delta\tau_a$ (243K)
0	1.000	1.000	0.000	0.000
20	1.000	1.000	0.000	0.000
40	1.002	1.002	0.001	0.001
50	1.003	1.004	0.002	0.002
60	1.006	1.007	0.003	0.004
65	1.009	1.011	0.004	0.005
70	1.013	1.016	0.005	0.006
75	1.022	1.026	0.006	0.007
80	1.039	1.048	0.007	0.009
82	1.053	1.065	0.008	0.009
84	1.078	1.094	0.009	0.011
86	1.127	1.154	0.010	0.013
88	1.278	1.339	0.014	0.017
90	∞	∞	∞	∞

Table 6: $Z=\cos\theta'/\cos\theta$, with θ' being the zenith angle with and θ being the zenith angle without refraction, for a summer and a winter atmosphere (T=273K, and 243K on the ground, respectively).
$\Delta\tau_a = \tau_a' - \tau_a$, with τ_a' being the aerosol optical depth with and τ_a being the aerosol optical depth without refraction, for a summer and a winter atmosphere.
All calculations were made for a station pressure of 101.3kPa.

least seasonally, of the order of 0.05 and below, the refraction correction is not negligible. Refraction has so far been ignored in all radiation studies known to the author of this thesis.

The use of hourly readings of I in equation 3.6 necessitates an integration of $\cos\theta(t)$ over one hour

$$\cos\theta=\int_{1\,hour}\cos\theta(t)dt/(1hour) \tag{3.14}$$

This integration was avoided by using mid-hour values of $\cos\theta(t)$, instead. The error incurred with this procedure is particularly low in the Arctic because $\cos\theta(t)$ does not change rapidly as the sun moves along the horizon.

3.2.4 Optical air mass

The optical air mass is a dimensionless quantity which is the ratio of the air-density weighted path length of a solar ray through the atmosphere to the air-density weighted path length of a ray from the zenith.

Neglecting the curvature of the earth and the refraction of the atmosphere, the air mass m is simply given by

$$m \doteq (\cos\theta)^{-1} \tag{3.15}$$

This is a good approximation for small zenith angles θ.

For solar positions close to the horizon the effects of curvature and refraction are not negligible and have to be taken into account. Kasten (1966) calculated m as being

$$m=1/(\cos\theta+0.1500(93.885-\theta)^{-1.253}) \qquad (3.16)$$

where the zenith angle θ has to be inserted in degrees. For $\theta=85^\circ$, m according to equation 3.16 is by 10% less than m according to equation 3.15, for $\theta=80^\circ$ the difference is still 3%, and for $\theta=70^\circ$ the difference is already less than 1%.

To account for variable station pressures m may be multiplied by a pressure correction term yielding the corrected air mass m′

$$m'=m(p/101.3) \qquad (3.17)$$

where the station pressure, p, has to be inserted in kilopascals. This correction is important if τ_a-results from stations at different elevations are to be compared.

From the definition of the optical air mass as an air-density weighted relative path length, it is obvious that its applicability is, strictly speaking, limited to Rayleigh scattering. This is so because the mixing ratios of ozone, water vapor, and aerosol are not constant with height. Seperate optical air masses should be calculated for every single hour, taking into account the actual vertical mixing ratio profiles. Due to the fact that the vertical ozone and aerosol profile is generally not known and the vertical water vapor profile would have to be interpolated from radiosonde observations at 12-hour intervals, and due to the circumstance that significant errors will probably occur only for very large zenith angles, no attempts have been made to account for that. An example taking account of the vertical profile of the aerosol mixing ratio can be found in a study by Dyer and Hicks (1968).

3.2.5 Ozone transmissivity

The transmissivity of solar radiation through the ozone layer of the atmosphere was calculated by Lacis and Hansen (1974) as

$$T_o = 1 - a_o^{vis}(um) - a_o^{uv}(um) \tag{3.18}$$

with

$$a_o^{vis}(um) = 0.02118um/(1+0.042um+0.000323(um)^2) \tag{3.19}$$

$$a_o^{uv}(um) = 1.082um/(1+138.6um)^{0.805} + 0.0658um/(1+(103.6um)^3) \tag{3.20}$$

u is the thickness of the vertical ozone column, measured in cm at normal temperature and pressure and m is the optical air mass.

The error in these formulas is supposed to exceed 0.5% for $um > 10$cm in equation 3.19 and for $um > 1$cm in equation 3.20. With u being usually about 0.5cm the limits for a 0.5% error are $m \doteqdot 20$ (or: $\theta \doteqdot 88^\circ$, according to equation 3.16) for a_o^{vis} and $m \doteqdot 2$ (or: $\theta \doteqdot 60^\circ$) for a_o^{uv}. Thus, the 0.5% error limit is practically never exceeded for the visible absorption term but is almost always exceeded for the ultraviolet absorption.

The error in τ_a incurred by the inaccuracy of equation 3.19 can be estimated from equations 3.6 and 3.18 by

$$\Delta\tau_a = \frac{\partial\tau_a}{\partial a_o^{uv}} \Delta a_o^{uv} = -\frac{1}{m} \frac{T_R}{(1 - a_o^{vis} - a_o^{uv}) T_R - a_w} \tag{3.21}$$

For a typical arctic situation, $\theta = 70^\circ$, $u = 0.5$cm, and the precipitable water $w = 0.3$cm. Therefore, $m = 2.9$, $um = 1.45$cm, $a_o^{vis} = 0.029$, $a_o^{uv} = 0.022$. As will be shown later, $T_R = 0.791$ and $a_w = 0.095$. Thus, for a 5% error in a_o^{uv}, the error in τ_a is ± 0.0005, and for a 50% error in a_o^{uv}, the error in τ_a is ± 0.005. In other words, as a 50% error is not likely, the inaccuracy in the ultraviolet absorption term for $um > 1$cm is most probably not capable of seriously affecting the τ_a-results.

Ozone is measured once daily at Resolute by different methods (Canada, Environment Canada etc., 1975ff.). No interpolation scheme for intermediate hours was introduced in the computer program. Day-to-day differences in ozone are usually not greater than 0.03cm NTP. For $u = 0.5$cm and $m = 2.9$, the error in ozone transmissivity is $\Delta T_o = \pm 0.002$. The error in τ_a can again be estimated by

$$\Delta\tau_a = \frac{\partial \tau_a}{\partial T_o}\Delta T_o = \frac{1}{m}\,\frac{T_R}{T_o T_R - a_w}\,\Delta T_o \qquad (3.22)$$

For the conditions mentioned above, the error in τ_a would amount to about ±0.0008 and is completely negligible. Now it is also clear that errors in the measurement of u and interpolated u-values for days with missing readings do not pose a threat to the precision of the results.

3.2.6 Rayleigh transmissivity

The Rayleigh transmissivity T_R of the atmosphere has been calculated various times with increasing accuracy since Rayleigh discovered a theoretical formulation for the amount of light scattered by molecules in 1871. A recent attempt was made by Davies and Idso in 1979. The result is expressed as a function of optical air mass m, for optical air mass increments of $\Delta m = 0.2$.

For greater accuracy, linear interpolation was used in this thesis. Some T_R-values may show that the transmissivity decreases only slowly with increasing air mass:

m	1	2	3	4	6	8	10	15
T_R	0.8973	0.8344	0.7872	0.7493	0.6907	0.6463	0.6108	0.5455

To account for variable station pressures, T_R should be multiplied by a pressure correction factor of p(kPa)/101.3.

The publication of Rayleigh transmissivities with 4 significant digits and the fact that linear interpolation produces errors of well below ±0.001 implies that the error in τ_a stemming from T_R is negligible.

3.2.7 Water vapor absorptivity

The absorptivity of solar radiation in air as a result of the presence of water vapor was calculated by Yamamoto (1962) from laboratory measurements made by Howard et al. (1955) (cited in Yamamoto, 1962). Lacis and Hansen (1974) found an empirical formula for Yamamoto's curve which applies to the atmosphere:

$$a_w=2.9wm/((1+141.5wm)^{0.635}+5.925wm) \tag{3.23}$$

w is the precipitable water measured in centimeters and m is the optical air mass.

As the measurements were made at standard temperature and pressure, and water vapor absorption is temperature and pressure dependent, a correction has to be applied (Lacis and Hansen, 1974):

$$wm_{eff}=wm\left(\frac{p}{101.3}\right)^{n}\left(\frac{273}{T}\right)^{0.5} \tag{3.24}$$

But as the absorption extends throughout the troposphere, the choice of appropriate values for pressure, p, and temperature, $\tilde{T}$, is a problem. Furthermore, the exponent, n, is only known to be approximately between 0.5 and 1.0. Lacis and Hansen, for example, take arbitrarily p=81kPa and make their calculations for n=0, 0.5, and 1.

As the uncertainties with these corrections are obviously great, no pressure correction was applied here and, as a first guess, the surface temperature was taken in the temperature correction term.

For the same situation used above ($\theta=70^\circ$, u=0.5cm, w=0.3cm) the error in a_w due to the neglect of the pressure correction can be estimated using p=81kPa and n=0.75: a_w turns out to be in error by $\Delta a_w = -0.004$. The influence of errors in a_w on τ_a may be estimated by

$$\Delta\tau_a = \frac{\partial\tau_a}{\partial a_w}\Delta a = -\frac{1}{m}\frac{1}{T_o T_R - a_w}\Delta a_w \qquad (3.25)$$

which yields in this example $\Delta\tau_a=0.002$. As will be seen later, this error is still about one order of magnitude less than the errors introduced by the uncertainties of the radiation measurements, and shall therefore be neglected.

Another error may be introduced by the use of equation 3.23 itself whose uncertainty supposedly exceeds 1% for $uw > 10$cm. The highest values of w occur in summer and may reach 1.5cm in the Arctic. With a high optical air mass of, e.g., m=10 ($\theta=85^\circ$), wm becomes 15cm. u is typically 0.35cm in summer. Thus, $T_o=0.910$, $T_R=0.611$, and $a_w=0.199$. For a 1% error in a_w, the error in τ_a is ±0.0006, but for a 10%

error in a_w, the error in τ_a is ±0.006 and approximately by a factor of 3 greater than the error incurred by neglecting the pressure correction. As the events of high precipitable water content and low solar elevation do not often occur simultaneously, the unknown error by extrapolating uw beyond the 10cm limit may not appreciably influence the final τ_a-values.

Precipitable water is being calculated twice daily for Resolute (for about 0600 hours and 1800 hours LAT) from radiosonde ascents. Linear interpolation is performed in the computer program to estimate precipitable water for intermediate hours. But precipitable water can change rapidly rather than smoothly with the advection of a different air mass (not to be confused with optical air mass). In a typical summer case, $m=2.9$ (or: $\theta=70^\circ$), $w=1.0$cm, and $\Delta w=0.3$cm over 12 hours. The typical maximum error by interpolation is therefore 0.3cm, and the maximum error in a_w is then about ±0.011. Using equation 3.25 with $u=0.35$cm the maximum error in τ_a amounts to ±0.006. But the fact that abrupt changes in precipitable water do not occur too often makes this error negligible for τ_a-mean values.

Precipitable water readings are presented with an accuracy of 0.01in (or: 0.025cm). This suggests that the errors from the published values are one order of magnitude less than the errors from the sudden jumps of precipitable water.

In some instances, precipitable water readings were not available. For these hours precipitable water was estimated from dewpoint temperature readings using a regression of the type

$$\ln(w)=\tilde{a}+\tilde{b}t_{\alpha} \tag{3.26}$$

where t_{α} denotes dewpoint temperature and $\tilde{a}$ and $\tilde{b}$ are constants. This formula was first derived by Reitan (1963) for monthly values of w and t_{α} and was shown to be applicable also for hourly values (Bolsenga, 1965).
For Resolute the equation was found to be

$$\ln(w)=-0.0878+0.0538t_{\alpha} \tag{3.27}$$

with w in cm and t_{α} in °C. To establish equation 3.27, 182 cases of hours with uninterrupted sunshine and simultaneous measurements ot w and t_{α} were used. The correlation coefficient is 0.93.

3.2.8 Selection of sunshine hours

The shortest periods for which climatic data are collected are hourly periods. Thus, to evaluate equation 3.6, hours with uninterrupted sunshine had to be found.

Sunshine observations are made with the Campbell-Stokes sunshine recorder (Canada, Environment Canada etc., 1978ff.) which is basically a glass sphere with a diameter of 10cm burning a narrow paper strip. The solar radiation flux density perpendicular to the rays must exceed values of 0.2cal/(cm^{2}min) (=140Wm^{-2}) (Bider, 1959) to 0.3cal/(cm^{2}min) (=210Wm^{-2}) (Brooks and Brooks, 1947) to give a burn. The threshold value is dependent on moisture and temperature and therefore tends to be higher for sunrise than for sunset (Bider, 1959). Taking, for example, τ_a=0.085, u=0.45cm, and w=0.3cm, 140Wm^{-2} and 210Wm^{-2} correspond to solar zenith angles of 86.6° and 85.3°, respectively.

There are two possible errors associated with Campbell-Stokes sunshine records: Firstly, the glass sphere may give a burn with the presence of clouds. To avoid this, all occurrences of uninterrupted sunshine observed in the presence of As, Cc, Cs, Ci, or fog at any cloud level were ignored. Secondly, if the solar disk is obstructed by clouds for short periods of about one minute or less the paper strip will show uninterrupted sunshine. Further errors are introduced by the fact that sunshine duration is published in tenths of an hour so that even a three minute interruption of direct sunshine would be recorded as a sunshine duration of 10/10. No remedy for these errors is available.

It is obvious that these errors systematically contribute to raising the τ_a-values. Another error which cannot be accounted for, but with the same tendency of raising the τ_a-values, stems from the pyranometers. Their readings are correct only if the glass hemispheres are completely clear. Any precipitation, dew, or hoar frost systematically lowers the radiation income and increases the resultant τ_a-values. Therefore, unexpectedly high τ_a-values have to be dealt with great caution, and may not represent the quantity they are supposed to stand for: aerosol optical depth.

For the three-year period from January 1st, 1978 to December 31st, 1980, 3183 hours of uninterrupted sunshine could be found at Resolute. But only for 537 hours are all necessary data available and no clouds of the types As, Cc, Cs, Ci, or fog reported. Of these 537 hours, 313 hours were reported to have 0/10 cloudiness, the remaining 224 hours had partial cloudiness of the cloud types not excluded.

3.3 Results and preliminary discussion

Appendix A contains all 537 hourly input data as well as the calculations of $\cos\theta$, T_o, T_R, a_w, and τ_a. Figure 3 presents the monthly results of 537 calculations of the aerosol optical depth at Resolute. As the distribution of the τ_a-values is usually not symmetric, medians were plotted rather than arithmetic means to avoid undue weighting of some, maybe erroneously, high τ_a-values. Section 3.2 has shown in detail that only two errors are important in the calculation of τ_a from equation 3.6: The errors in the pyranometer readings, which were reported as being as high as 5%, and the errors in the solar constant, being

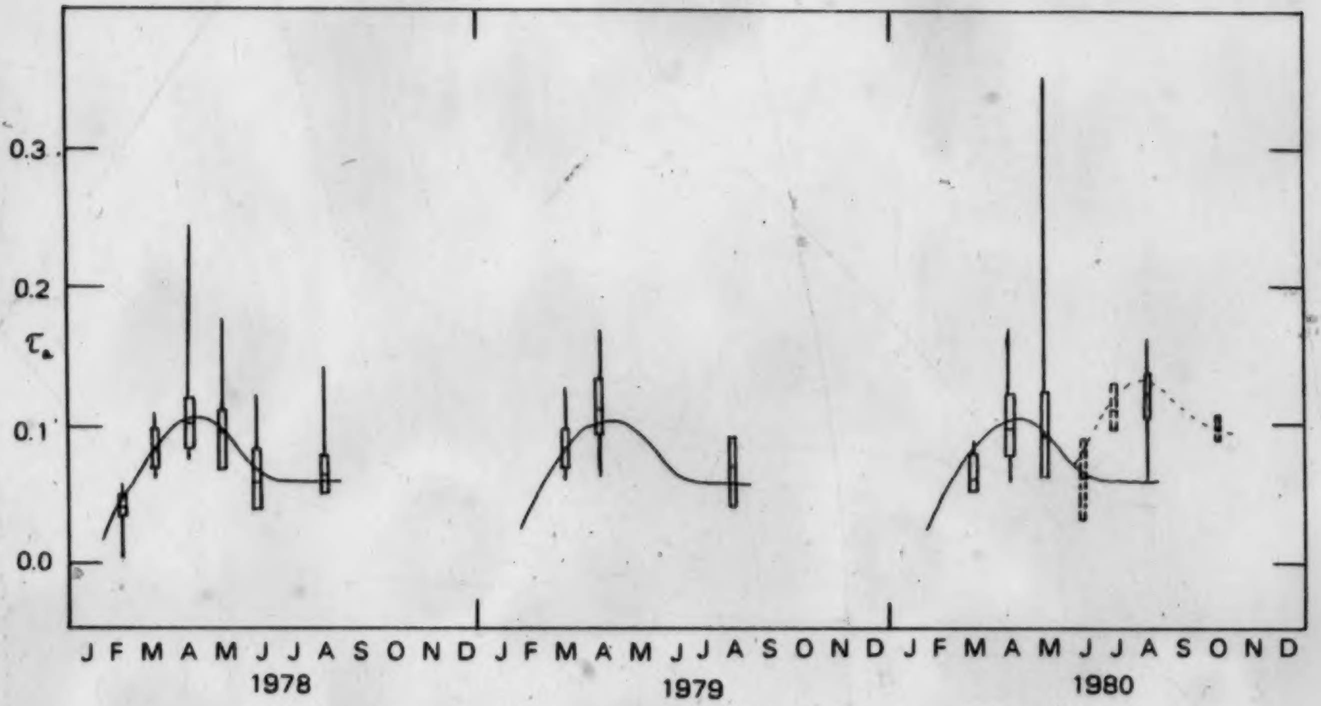
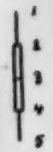


Figure 3: Aerosol optical depth τ_a at Resolute.
The error bars have the following meaning: Position 3 indicates the median; positions 1 and 5 indicate the range inside which 68% of all values are located, positions 2 and 4 indicate the medians if all radiation measurements are in error by 5% and the solar constant, simultaneously, is in error by 1%.
The dotted bars and the dotted line indicate the influence of the eruption of Mt. St. Helens.



approximately 1%.

To account for these errors all calculations were performed again with all pyranometer readings lowered by 5% and the solar constant simultaneously raised by 1%. Then, all calculations were performed with all pyranometer readings raised by 5% and the solar constant simultaneously lowered by 1%. The first procedure results in higher, the second in lower τ_a-values. These adjusted medians are also shown in Figure 3.

Each error bar in Figure 3 contains a wide and a narrow section: The wide section indicates the range between the median of τ_a with all pyranometer readings lowered by 5% and the solar constant raised by 1%, and the median of τ_a with all pyranometer readings raised by 5% and the solar constant lowered by 1%. The narrow section indicates the range within which 68% of all τ_a-values can be found in the original calculation with the original pyranometer readings and a solar constant of $1353 Wm^{-2}$.

In Figure 3 only those months are shown for which at least 10 calculations of τ_a could be made. Months with fewer than 10 calculations were not rejected if data were available for at least 3 different days.

The monthly results averaged over three years can be expressed as follows:

Feb. 0.04

Mar. 0.08

Apr. 0.10

May	0.09
Jun.	0.06
Jul.	(0.06?)
Aug.	0.06

The results show a systematic seasonal march of the aerosol optical depth: τ_a increases from low values in late winter to a distinct maximum in April and May. It decreases in June and remains at a medium to high level all summer.

The very high values for August 1980 are probably due to the eruption of the volcano Mt. St. Helens in Washington State on May 18th, 1980. Similar repercussions of volcanic events on the aerosol optical depth have been studied many times. An impressive example for the diffusion of high aerosol turbidity after the eruption of Mt. Agung on Bali on March 17th, 1963, was documented by Dyer and Hicks (1968) and Volz (1970). In this case the aerosol optical depth reached its normal value only after more than two years.

To elucidate the volcanic influence on the aerosol optical depth at Resolute, the medians for June, July, and October 1980 were plotted with dots in Figure 3. They were not plotted with solid lines because they do not fulfill the criteria for medians set above. The volcanic influence reached its maximum in August 1980 with a delay of 3 months and tapered off in fall 1980. But this is only true if the seasonal 'background aerosol' itself (solid line in Figure 3) remains constant in fall which cannot be inferred from Figure 3.

Setting aside the unique volcanic event in 1980, the following can be said about the aerosol optical depth at Resolute compared to other arctic stations (see Tables 2 and 3):

τ_a is approximately of the same size as in other arctic locations. This is especially true for summer; the values for the period of highest turbidity, spring, are somewhat lower at Resolute. This is one more confirmation that the τ_a -values calculated from integrating nephelometer measurements of β_{as} (bracketed in Tables 2 and 3) are much too low.

The results from Resolute also confirm that it is not justified to call winter the season of high and summer the season of low turbidity. At least for Resolute, spring and only spring is the season of high turbidity whereas winter, as far as can be seen from Figure 3, is rather a period of low turbidity. The arguments in favor of or against a particular continent as the origin of high turbidity in the Arctic must be seen in the light of these findings. But a detailed discussion of the problem of the origin must be put off until further computational results are known in Chapter 5.

3.4 Further results

It might be of interest to find out whether τ_a for cloudy hours is different from τ_a for cloudless hours. For cloudy hours τ_a might be greater, because with the presence of clouds there might be some atmospheric layers, even in the cloudless portion of the sky, where relative humidity approaches 100%.

In recent years, a multitude of studies have been published (e.g. Covert et al., 1972; Hänel, 1972; Zuyev et al., 1973; Hänel and Bullrich, 1978; Fitzgerald, 1980) which examine the functional relationship between the aerosol particle radius (or the scattering coefficient) and relative humidity. As a rule it can be said that the particle radius, and hence the scattering coefficient, increases only slightly as long as relative humidity is below about 80%. Above about 80%, particles grow very fast and reach the size of small cloud droplets at 100%. This is the well-known phenomenon of haze.

The median of τ_a for all 537 cases considered is found to be 0.088. For the 313 cases of cloudless skies τ_a is only slightly different and amounts to 0.087. Also, the correlation coefficient between τ_a and cloud amount is found to be only 0.26. Thus, the effect of increasing τ_a with increasing cloudiness could not be proved.

The correlation coefficient between τ_a and relative humidity at station height amounts to only 0.06 and also fails to show the desired relationship. This is so because relative humidity exceeded 80% only in 17% of all cases.

Visibility is being reported hourly at Resolute. It should be expected that τ_a is high for low visibilities and vice versa. But the correlation coefficient amounts to 0.01 and is even of the wrong sign. This is probably due to the fact that visibility is not measured, but estimated from watching some remote objects (mountains etc.) at known distances. Furthermore, visibility is not a continuous variable as only a limited number of landmarks are used for its estimation.

An important question is whether τ_a shows different values for winds from certain directions or for calms:

To examine the dependence on wind direction winds were divided into two classes: northerly and easterly winds blowing from directions 315° and clockwise through 135°, and southerly and westerly winds from directions between 135° and 315°. To determine whether occurrences of very high aerosol turbidity ($\tau_a > 0.168$) or very low aerosol turbidity ($\tau_a < 0.056$) are associated with winds from a particular direction χ^2-tests were performed on Tables 7a and 7b. The results were negative, or, in other words: No significant relationship could be established between occurrences of high turbidity and wind direction, nor could a significant relationship be established between low turbidity and winds from a particular direction.

For Resolute, the northerly and easterly directions are those facing Asia and Europe, and the southerly and westerly directions are facing North America. The lack of any relationship is in stark contrast to the claims of Peterson et al. (1980) that northerly winds at Barrow carry higher aerosol turbidities than southerly winds (see Table 2).

To examine whether there is any relationship between the occurrence of calms at Resolute and the occurrence of high turbidity ($\tau_a > 0.168$) or the occurrence of low turbidity ($\tau_a < 0.056$) two more χ^2-tests were performed (Tables 7c and 7d). Once again, the results were negative indicating that occurrences of extremely high or low turbidity are not linked to calms.

Only the median of the τ_a-values at calms is slightly higher than the median for all cases: 0.103 versus 0.088.

From this it must be concluded that high turbidity is not a local phenomenon, i.e., not induced by local pollution sources. But a more thorough discussion of these findings has to wait until, in a later chapter, more computational results are known.

τ_a	< 0.168	>0.168
wind dir.:		
north+east	300	48
south+west	110	17

(a)

τ_a	< 0.056	>0.056
wind dir.:		
north+east	66	282
south+west	23	104

(b)

τ_a	< 0.168	>0.168
winds	410	65
calms	50	12

(c)

τ_a	< 0.056	>0.056
winds	89	386
calms	8	54

(d)

Table 7: Simultaneous occurrences of high (a) and low (b) aerosol turbidities and winds from either northerly and easterly or southerly and westerly directions. Simultaneous occurrences of high (c) and low (d) turbidities and calms.

4. Aerosol single-scattering albedo at Resolute

4.1 Introduction

There are various methods to determine the single-scattering albedo or, alternatively, the imaginary part of the refractive index of an aerosol. They can be divided into two classes: laboratory methods and field-experiment methods.

The majority of the results given in Tables 4 and 5 were obtained in laboratories using atmospheric aerosol samples collected either at ground or by aircraft. Laboratory methods, in turn, can be divided into two classes: Either the volume-absorption and volume-scattering coefficients are determined directly or the angular distribution of the scattered radiation is recorded with a scanning nephelometer and the result compared with scattering phase functions derived from complete solutions of the Mie scattering theory for various particle size-distributions and imaginary parts.

There are three major disadvantages associated with laboratory methods: Firstly, there is reason to fear that the aerosol undergoes changes , e.g. in size-distribution and water coating, after it has been collected. Secondly, samples taken at ground level do not represent the mean conditions of the entire atmosphere, only those of the surface boundary layer. Thirdly, since laboratory methods are time and money consuming, the number of samples is generally not sufficient to gain climatological mean values.

Field-experiment methods, on the other hand, directly measure the interaction of solar radiation with the aerosol in the atmosphere. Therefore, they are in essence solutions to the problem of solar radiation transfer. As the method used in this thesis can also be classified as a field-experiment method, a short literature review of other similar approaches will be given on the following pages.

Roach (1961) and Method and Carlson (1982) made radiation measurements from aircraft at different altitudes and immediately derived the absorbed, upward scattered, and downward scattered fluxes in an atmospheric layer. Generally, the use of aircraft immediately provides the data necessary to calculate ω_0. But, for obvious reasons, ω_0 has to be determined from ground-based measurements in most cases. This implies that models have to be used that predict the diffuse downwelling radiation at ground level.

Forbes and Hamilton (1971), used a very simple radiative transfer model which gives doubtful results, as noted in Chapter 2.

Herman et al. (1975) present the so-called diffuse-direct radiation method: It is based on spectral intervals for which only Rayleigh scattering and aerosol extinction are relevant. The radiative transfer problem is solved using a plane-parallel atmosphere with a presumed vertical aerosol distribution according to Elterman (1964) and a Junge aerosol size-distribution. Calculations of the total diffuse flux at the ground D↓ as a function of the solar zenith angle θ, the wavelength λ, the aerosol optical depth τ_a, the complex index of refraction $n=n_1-in_2$, and the surface albedo 'a' are thereby obtained. The direct solar flux at the ground on a surface perpendicular to the solar rays I' can also be obtained (see Chapter 3). Next, a multitude of diagrams is plotted showing the ratio $D{\downarrow}/I'$ versus n_2 with θ, λ, τ_a, and 'a' as parameters. With D↓ and I' measured for a wavelength λ, and θ, τ_a, and 'a' known, n_2 can be derived by interpolating between the diagrams. This method has also been used by DeLuisi et al. (1976) and, in a modified version, by Carlson and Caverly (1977). The foregoing diffuse-direct method was extended by King and Herman (1979) to derive n_2 and 'a' simultaneously and was applied by King (1979).

The diffuse-direct method cannot apply to the data available for the Canadian Arctic because spectral radiation measurements are not taken there. Another disadvantage of the 1975-version is the fact that interpolations have to be performed between various diagrams. The 1979-version, according to King (1979), necessitates 'a clear atmosphere for a long enough period of time for the solar zenith angle to undergo a large change, preferably of about 40°'. This requirement also excludes its application to the Arctic.

The foregoing introduction has introduced and eliminated approaches which calculate the single-scattering albedo using airborne measurements or spectral measurements because such measurements are not available for Canada's Arctic.

The present author believes that no attempts have so far been made to calculate ω_o or n_2 in the most straightforward way which is to solve empirical or theoretical radiative transfer models for ω_o or n_2.

In this study the present author attempts to apply increasingly complicated models for all hours with a sunshine duration of 10/10 and 0/10 cloudiness (and all other relevant data available) to calculate ω_o for the entire solar spectrum at Resolute for the period from January 1978 to December 1980.

4.2 Davies-Hay model

There have always been two largely independent approaches to the radiative transfer problem: Firstly, there is a purely empirical approach which might also be called the single-scattering approach, because it assumes that diffuse radiation is only scattered once on its way from the sun to the bottom of the atmosphere. To use this approach transmissivities for the whole atmosphere are needed and, for the most part, readily obtained. Secondly, there are theoretical or multiple-scattering approaches, a very popular version of which is the two-stream approximation. For this approach, volume-extinction coefficients are needed which are, for the case of the entire solar spectrum, not as easily obtained as are the transmissivities used in the single-scattering approach.

Sheppard (1958) suggests that, as a thumb rule, single-scattering approaches may be used if the total transmissivity of the direct solar beam exceeds 0.90, and multiple-scattering has to be used if it is less than 0.74. This suggests that in the Arctic, with its low Rayleigh transmissivity, the latter is always mandatory.

This section deals with the latest version of the single-scattering approach, that of Davies and Hay (1980), whereas the following sections deal with various two-stream approximations.

The grandfathers of empirical radiative transfer are Linke and Ångström, for total and spectral direct solar radiation fluxes, respectively. Linke's turbidity factor was used from the 1920s to the 1950s. In 1954, Houghton came up with a new empirical radiative transfer model which was still rather simple with respect to the atmospheric aerosol. This model was modified by Monteith (1962), Idso (1969,1970), Davies et al. (1975), Suckling and Hay (1976), Paltridge and Platt (1976,p.121), Davies and Idso (1979), and finally by Davies and Hay (1980). This latest version is a sophisticated empirical solar radiation transfer approximation, and will be used as a first attempt to calculate the single-scattering albedo. Hereinafter it will be referred to as Davies-Hay model.

According to the Davies-Hay model the downwelling diffuse radiation $D\downarrow$ at the bottom of the atmosphere for cloudless conditions can be written as:

$$D\downarrow = D_R + D_A + D_S \tag{4.1}$$

with:

$$D_R = T_o \frac{1-T_R}{2} T_a I_o \cos\theta \tag{4.2}$$

$$D_A = (T_o T_R - a_w)(1-T_a)\omega_o B_a I_o \cos\theta \tag{4.3}$$

$$D_S = a\alpha(I + D_R + D_A)/(1-a\alpha) \tag{4.4}$$

D_R, D_A, and D_S are the diffuse fluxes due to Rayleigh scattering, aerosol scattering, and multiple reflection of global radiation between the surface and the clear atmosphere, respectively. I_o, I, θ, T_o, T_R, T_a, and a_w have the same meanings as in the previous chapters. ω_o is the single-scattering albedo for the aerosol, B_a is the ratio of downward to total aerosol scatter for direct radiation, a is the surface albedo and α is the albedo of the clear sky for upwelling global radiation which is in the Davies-Hay model

$$\alpha = 0.0685 + (1-T_a)\omega_o(1-B_a^{\uparrow}) \tag{4.5}$$

The first term represents the albedo due to Rayleigh backscattering and the second term the albedo for aerosol backscattering. $B_a^{\uparrow}$ is the ratio of upward to total aerosol scatter for upwelling global radiation.

The surface albedo can be obtained from measurements of the upwelling global and the downwelling global radiation. Both are measured at Resolute. The only new quantities are B_a and $B_a^{\uparrow}$.

B_a is a function of the zenith angle of the impinging radiation. This is so because the aerosol scattering phase function (which indicates the amount of radiation scattered into an infinitesimal solid angle as function of the scattering angle) is highly asymmetric with respect to the scattering angle but symmetric with respect to the azimuthal angle and has the shape of a club with a marked forward peak, minima at around right angles to the impinging radiation, and a minor maximum in the backward direction. Now, it can easily be understood that with the sun being at zenith, 'the club points downward', in other words, most of the radiation is scattered downward to the earth. At sunrise and sunset, 'the club is lying horizontally' and, therefore, whatever shape the club has, 50% of the radiation is scattered down to the earth and 50% back to space.

Various values for the percentage of downward to total aerosol scatter, B_a, with the sun being at zenith have been measured: 0.94 (Roach, 1961), 0.92 (Robinson, 1962), 0.80-0.94 (Charlson et al., 1974), 0.83-0.94 (Waggoner et al., 1981), and 0.88 (Method and Carlson, 1982). Much more difficult to find in literature is the variation of B_a with the solar zenith angle θ. So far, only Robinson (1962) has published measurements:

$\cos\theta$	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2
B_a	.92	.91	.89	.86	.83	.78	.71	.67	.60

Therefore, these data were taken as an estimate and graphically interpolated for all values of $\cos\theta$. As $B_a(\theta=0^\circ)=0.92$ seems to be slightly too high with regard to the more recent findings, $B_a(\theta=0^\circ)=0.90$ was taken and the whole function $B_a(\theta)$ proportionally shifted to slightly lower values.

The upward to total aerosol scatter for upwelling radiation $B_a^\uparrow$ poses another problem: No uniform zenith angle can be allotted to diffuse radiation. But, as will be shown in the section on two-stream approximations, it is common practice to assume that, at least upwelling, diffuse radiation traverses a 'mean' optical air mass of 1.66 which corresponds to a zenith angle of 53°. Therefore, $B_a^\uparrow=B_a(\theta=53^\circ)=0.81$ was taken.

Three more things have to be explained in the Davies-Hay model (equations 4.1 to 4.5):

Firstly, the scattering phase function for Rayleigh scattering has the shape of a bone with identical maxima in the forward and backward direction and a symmetrical minimum at right angles to the impinging radiation. Therefore, the downward to total scattering ratio is always exactly 50% for any 'location of the bone'. This is the reason for the factor 1/2 in equation 4.2.

Secondly, as Rayleigh scattering is restricted to the shorter wavelengths and water vapor absorption to the longer wavelengths, no water vapor absorption term was introduced in equation 4.2.

Thirdly, the multiple reflection term (equation 4.4) can easily be understood after a Taylor-expansion is applied to it. This yields:

$$D_S = (I + D_R + D_A)(a\alpha + a^2\alpha^2 + a^3\alpha^3 + \ldots) \qquad (4.6)$$

Now, equations 4.1 to 4.5 can be solved for ω_o because all other variables are known, namely:

-T_o : from equations 3.18 to 3.20;
-T_R : from Section 3.2.6;
-a_w : from equation 3.23;
-$T_a = \exp(-\tau_a m)$: τ_a from the result of calculations made in Chapter 3; m from equation 3.16;
-I_0 : from Section 3.2.1;
-$\cos\theta$: from equations 3.9 to 3.12;
-B_a, $B_a^{\uparrow}$: from Robinson (1962), as discussed in this section;
-a : from measurements of the global downwelling and upwelling radiation.

The results of these calculations will be given at the end of this Chapter.

4.3 Two-stream approximation

The two-stream approximation of radiative transfer was proposed by Schuster (1905) and has since been subjected to considerable sophistication. The field of diffuse solar radiation at some height z in the atmosphere is thought of consisting of two 'streams' or fluxes: the upwelling and the downwelling diffuse flux, $D\uparrow(z)$ and $D\downarrow(z)$. In a height element dz, the two fluxes are subject to changes $dD\uparrow(z)$ and $dD\downarrow(z)$, respectively. They decrease because of absorption and scattering-out, but they increase because part of the opposing flux is scattered in and because at any height of the atmosphere the direct solar beam acts as a source of diffuse radiation through scattering.

This yields a system of two inhomogeneous differential equations:

$$\frac{dD\uparrow(z)}{dz} = -a_{11}D\uparrow(z) + a_{12}D\downarrow(z) + b_1 f(z) \tag{4.7}$$

$$\frac{dD\downarrow(z)}{dz} = -a_{21}D\uparrow(z) + a_{22}D\downarrow(z) - b_2 f(z) \tag{4.8}$$

If we assume that ozone absorption is already completed when the solar beam hits the top of the atmosphere, only Rayleigh scattering, aerosol scattering, water vapor absorption, and aerosol absorption have to be condidered. Then the matrix elements a_{ij}, the vector elements b_i, and the source function f(z), describing the direct beam, become:

$$a_{11}=m\uparrow(\beta_w^{\uparrow}+\tfrac{1}{2}\beta_R^{\uparrow}+\beta_a(1-\omega_0 B_a^{\uparrow})) \tag{4.9}$$

$$a_{12}=m\downarrow(\tfrac{1}{2}\beta_R^{\downarrow}+\beta_a\,\omega_0(1-B_a^{\downarrow})) \tag{4.10}$$

$$a_{21}=m\uparrow(\tfrac{1}{2}\beta_R^{\uparrow}+\beta_a\,\omega_0(1-B_a^{\uparrow})) \tag{4.11}$$

$$a_{22}=m\downarrow(\beta_w^{\downarrow}+\tfrac{1}{2}\beta_R^{\downarrow}+\beta_a(1-\omega_0 B_a^{\downarrow})) \tag{4.12}$$

$$b_1=I_0\,T_0\,(\tfrac{1}{2}\beta_R+\beta_a\,\omega_0(1-B_a)) \tag{4.13}$$

$$b_2=I_0\,T_0\,(\tfrac{1}{2}\beta_R+\beta_a\,\omega_0\,B_a \tag{4.14}$$

$$f(z)=(T_R-a_w)T_a=$$

$$=(\exp(-\tau_R m)-(1-\exp(-\tau_w m)))\exp(-\tau_a m)=$$

$$=(\exp(-\beta_R\frac{H-z}{\cos\theta})+\exp(-\beta_w\frac{H-z}{\cos\theta})-1)\exp(-\beta_a\frac{H-z}{\cos\theta}) \tag{4.15}$$

At this point it should be mentioned that in all previous two-stream approximations known to this author the distinction between the various terms involving atmospheric absorbers and scatterers in equations 4.9 to 4.15 were not as thorough. The problem of evaluating these coefficients will be dealt with in more detail in Section 4.4 than can be found elsewhere in literature. It must therefore be stressed that the set of equations 4.9 to 4.15 is based on a physical development more so than on previous literature. As the inhomogeneity or source function (equations 4.13 to 4.15) has not been used in this form before, a complete solution of this system of inhomogeneous differential equations could not be found elsewhere in literature.

Let us now return to equations 4.9 to 4.15. $m\uparrow$ and $m\downarrow$ are the diffusivity factors for upwelling and downwelling diffuse radiation, respectively. Details of their meaning will be given in Section 4.4.1.

$\beta_w^\uparrow$, $\beta_w^\downarrow$, β_w, and τ_w are the water vapor volume absorption coefficients and the water vapor optical depth, respectively; $\beta_R^\uparrow$, $\beta_R^\downarrow$, β_R, and τ_R are the Rayleigh volume scattering coefficients and the Rayleigh optical depth, respectively; the definitions of these quantities are analogous to the definitions of β_a and τ_a (see equations 2.9 and 2.4). Reasons to introduce three different β_w-coefficients and three different β_R-coefficients will be given in Sections 4.4.4 and 4.4.3., respectively.

A distinction between $B_a^\uparrow$ and $B_a^\downarrow$ has also been made, the first variable denoting the upward to total aerosol scatter ratio for upwelling diffuse radiation, and the latter one denoting the downward to total aerosol scatter ratio for downwelling diffuse radiation. The reason for this distinction will also be given in Section 4.4.1.

A finite height H of the atmosphere has been introduced to find an expression for the source function f(z) in regular height coordinates. The implications of this step will be discussed in Section 4.4.2. All other quantities in equations 4.9 to 4.15 are the same as defined earlier.

Two things have to be said about the source functions $b_1 f(z)$ and $b_2 f(z)$, which describe the conversion of direct solar radiation to diffuse radiation. As T_o is not incorporated in f(z) the total transmissivity for the direct beam is $T_o(T_R - a_w)T_a$ rather than $(T_o T_R - a_w)T_a$ as used in Chapter 3. As T_o is almost always greater than 0.90 and in many cases close to 0.95 the difference between these formulas is typically of the order of 1%. Furthermore, it should be mentioned that the $\cos\theta$-term does not appear in the source function. To make this plausible, consider a volume element in the atmosphere and imagine, for the moment, that the direct solar radiation streaming through this volume element has not been attenuated at all before it reaches the volume element. Then it is immediately obvious that the amount of radiation scattered inside the volume element, in other words the intensity of the source of diffuse radiation, is the same for any zenith angle of the impinging solar radiation. The fact that, in reality, radiation has already been attenuated before it reaches the volume element and that the intensity of the source is thus a function of the solar zenith angle is, of course, being considered by means of the factors T_o, T_R, T_a, and a_w.

The analytical solution of this system of two inhomogeneous differential equations (equations 4.7 to 4.8) is tedious but mathematically straightforward (see, e.g., Bronstein and Semendjajew, 1976, pp.391f.): The most general solution of the homogeneous system (i.e., for $f(z)=0$) turns out to be

$$D\uparrow(z)=C_1\exp(r_1 z)+C_2\exp(r_2 z) \tag{4.16}$$

$$D\downarrow(z)=\frac{a_{11}+r_1}{a_{12}}C_1\exp(r_1 z)+\frac{a_{11}+r_2}{a_{12}}C_2\exp(r_2 z) \tag{4.17}$$

where r_1 and r_2 are the eigenvalues of the homogeneous system

$$r_{1/2}=\frac{1}{2}\left(a_{22}-a_{11}\pm\sqrt{(a_{11}-a_{22})^2-4(a_{12}a_{21}-a_{11}a_{22})}\right) \tag{4.18}$$

with $r_1 > r_2$. C_1 and C_2 are arbitrary constants. To get one particular solution of the inhomogeneous system (i.e., for $f(z)\neq 0$) we assume $C_1=C_1(z)$ and $C_2=C_2(z)$ and insert equations 4.16 and 4.17 into 4.7 and 4.8. This yields an inhomogeneous system of algebraic equations with the unknowns $C_1'(z)$ and $C_2'(z)$ where the prime denotes the first derivative with respect to z. This system can immediately be solved for $C_1'(z)$ and $C_2'(z)$, and $C_1(z)$ and $C_2(z)$ can be found by simple integration. As we need only one particular solution we set the integration constants equal to zero. Inserting $C_1(z)$ and $C_2(z)$ into equations 4.16 and 4.17 yields the desired particular solution. The most general solution of the inhomogeneous system is then simply the sum of the most general solution of the homogeneous system (equations 4.16 and 4.17) and the particular solution of the inhomogeneous system.

This system still has two arbitrary constants, C_1 and C_2. Therefore, two boundary conditions are required. They are:

$$D\downarrow(z=H)=0 \tag{4.19}$$

$$D\uparrow(z=0)=a(D\downarrow(z=0)+I(z=0)) \tag{4.20}$$

$I(z=0)$ means the direct horizontal solar radiation at the ground and 'a' the surface albedo.

As we are only interested in $D\downarrow(z=0)$ (in the Davies-Hay model denoted by $D\downarrow$) only this result shall be given here:

$$D\downarrow=\left(\frac{a_{11}+r_1}{a_{12}}(C_1+D_1)+\frac{a_{11}+r_2}{a_{12}}(C_2+D_2)\right)I_0 T_0 \tag{4.21}$$

$$C_1=\frac{(E_1(a_{12}-a(a_{11}+r_2))-E_2(a_{11}+r_2)e^{r_2H})a_{12}}{(a_{12}-a(a_{11}+r_2))(a_{11}+r_1)e^{r_1H}-(a_{12}-a(a_{11}+r_1))(a_{11}+r_2)e^{r_2H}} \tag{4.22}$$

$$C_2=\frac{E_2 a_{12}}{a_{12}-a(a_{11}+r_2)}-\frac{a_{12}-a(a_{11}+r_1)}{a_{12}-a(a_{11}+r_2)}C_1 \tag{4.23}$$

$$D_1=\frac{b_1(a_{11}+r_2)+b_2a_{12}}{r_2-r_1}\left(\frac{e^{-F_1H}}{F_1-r_1}+\frac{e^{-F_2H}}{F_2-r_1}-\frac{e^{-F_3H}}{F_3-r_1}\right) \tag{4.24}$$

$$D_2=\frac{b_1(a_{11}+r_1)+b_2a_{12}}{r_2-r_1}\left(\frac{e^{-F_1H}}{F_1-r_2}+\frac{e^{-F_2H}}{F_2-r_2}-\frac{e^{-F_3H}}{F_3-r_2}\right) \tag{4.25}$$

$$\begin{aligned}E_1=&-\frac{a_{11}+r_1}{a_{12}}\frac{b_1(a_{11}+r_2)+b_2a_{12}}{r_2-r_1}\left(\frac{1}{F_1-r_1}+\frac{1}{F_2-r_1}-\frac{1}{F_3-r_1}\right)\\&+\frac{a_{11}+r_2}{a_{12}}\frac{b_1(a_{11}+r_1)+b_2a_{12}}{r_2-r_1}\left(\frac{1}{F_1-r_2}+\frac{1}{F_2-r_2}-\frac{1}{F_3-r_2}\right)\end{aligned} \tag{4.26}$$

$$E_2 = D_1\left(\frac{a(a_{11}+r_1)}{a_{12}}-1\right)+D_2\left(\frac{a(a_{11}+r_2)}{a_{12}}-1\right)$$

$$+\cos\theta(\exp(-F_1 H)+\exp(-F_2 H)-\exp(-F_3 H) \qquad (4.27)$$

$$F_1 = (\beta_R + \beta_a)/\cos\theta \qquad (4.28)$$

$$F_2 = (\beta_w + \beta_a)/\cos\theta \qquad (4.29)$$

$$F_3 = \beta_a/\cos\theta \qquad (4.30)$$

As D↓ is being measured, equation 4.21 can be comprehended as an extremely complicated transcendental function in ω_0 which can be numerically solved for ω_0. This requires that all the other variables occuring in equations 4.9 to 4.15 are known. This is actually the case. The next section will show how they can be evaluated.

4.4 Evaluation of the two-stream approximation

4.4.1 Diffusivity factors m and aerosol scattering ratios B

The diffusivity factors, m↑ and m↓, for diffuse radiation are analogous to the optical air mass m for direct radiation. They are simply magnification factors, indicating by how many times the path length of radiation through the entire atmosphere is greater than the shortest possible path length at vertical incidence. For direct radiation this problem is easily solved (equations 3.15 and 3.16). For diffuse radiation, whether upwelling or downwelling, an appropriate magnification factor has to be found which is an average value for radiation from one entire hemisphere.

If the diffuse radiation is isotropic (i.e., the intensity is independent of direction for the entire hemisphere considered) then the problem can be solved numerically (see Kondratyev, 1969, p18f.) with the result that the diffusivity factor ranges between 1.2 for an intransparent atmosphere and 2.0 for a completely transparent atmosphere. But for the wide range of diffuse radiation transmissivities from 0.2 to 0.8 an average value of 1.66 can be applied with no more than 10% error. The factor 1.66 has found its way into many radiation studies.

The problem of finding a diffusivity factor for isotropic diffuse radiation has also been tackled by Chandrasekhar (1950,p.54f.) who comes up with the result $\sqrt{3} = 1.73...$ as a first order approximation to the problem.

In recent years, the latter value has become popular (e.g., Sagan and Pollack, 1967; Liou, 1974; Liou, 1980, p.184ff.; Paltridge and Platt, 1976, p.100), although in some cases even the value 2.0 finds application (Paltridge and Platt, 1976, p.73f.; Chýlek and Coakley, 1974).

Unfortunately, the problem of finding appropriate diffusivity factors is much more complicated because the isotropy assumption does usually not hold. This is especially true for downwelling diffuse radiation. The reason for anisotropy of downwelling diffuse radiation is the deviation from sphericity of the Rayleigh and, above all, the aerosol phase functions which were previously described as a bone and a club, respectively. Therefore, the bulk of downwelling diffuse radiation has a zenith angle similar to that of the sun. For upwelling diffuse radiation at height z, the isotropy assumption is fulfilled if the ground acts as a perfectly isotropic rather than partially specular reflector and the anisotropic upwelling diffuse radiation stemming from backscattering inside the atmosphere between the ground and height z is ignored for a moment. But it is known from everyday experience that certain surfaces, above all flat water but also ice and melting snow covered with a thin ice sheet, give highly anisotropic and almost specular reflections.

For some unknown reason the problem of anisotropy of diffuse radiation has largely been ignored in the discussion of diffusivity factors. Only Kondratyev (1969,p.207) mentions some work done by Kondratyev and Senderikhina (1959) to evaluate the diffusivity factors from intensity measurements over the upper and lower hemisphere. Measurements were made in the Leningrad region and on the Crimea but the surface conditions were not reported. Their result, formulated below, shows a considerable functional dependence of the diffusivity factors $m\uparrow$ and $m\downarrow$ on the cosine of the solar zenith angle θ:

$$m\uparrow=(0.21/\cos\theta)+1.73 \qquad (0^\circ\leq\theta\leq75^\circ) \qquad (4.31)$$

$$m\downarrow=(0.54/\cos\theta)+1.09 \qquad (0^\circ\leq\theta\leq73^\circ) \qquad (4.32)$$

For great zenith angles θ, which are of particular importance in the Arctic, these diffusivity factors may assume very great values and are considerably different from the diffusivity factors mentioned before. Therefore, it appears necessary that all calculations in this study be made with at least two different sets of diffusivity factors: In a first calculation the diffusivity factors of equations 4.31 and 4.32 were taken. These calculations will hereinafter be referred to as Kondratyev-model. In a second calculation the diffusivity factors

$$m\uparrow=m\downarrow=1.66 \qquad (4.33)$$

were chosen which will be referred to as 1.66-model.

Now the appropriate choice of the upward to total aerosol scatter ratio $B_a^{\uparrow}$ for upwelling diffuse radiation and the downward to total aerosol scatter ratio $B_a^{\downarrow}$ for downwelling diffuse radiation can be made by assuming that the diffuse radiations from the lower and the upper hemispheres behave as if they had zenith angles $\theta\uparrow$ and $\theta\downarrow$ defined by

$$\theta\uparrow=\arccos(1/m\uparrow) \qquad (4.34)$$

$$\theta\downarrow=\arccos(1/m\downarrow) \qquad (4.35)$$

Then the aerosol scatter ratios $B_a^\uparrow$ and $B_a^\downarrow$ can immediately be taken from the table given by Robinson (1962) (see Section 4.2).

4.4.2 Height of the atmosphere and volume extinction coefficients

The factors β_w, β_R, and β_a in equations 4.9 to 4.15 are not functions of height. Therefore, we have to introduce two assumptions: Firstly, we have to assume that the mixing ratios of water vapor and aerosol are constant for the entire atmosphere. In the next section (4.5) this somewhat unrealistic assumption will be relaxed by dividing the atmosphere into two layers at 50kPa and distributing water vapor and aerosol in a more realistic fashion. But even with the assumption of constant mixing ratios the volume extinction coefficients β_w, β_R, and β_a taper off with height at the same rate density decreases with height. Therefore, an atmosphere with constant density has to be introduced which has a finite height. To relate this finite height with parameters of the real atmosphere an isothermal atmosphere has to be assumed (this assumption holds in the Arctic better than anywhere else). Integrating the density-height function of the real but isothermal atmosphere

$$\rho(z)=\rho(z=0)\exp(-gz/R\tilde{T}) \qquad (4.36)$$

with respect to z from 0 to ∞ yields that an atmosphere of constant density $\rho=\rho(z=0)$ has a finite height H given by

$$H=R\tilde{T}/g \qquad (4.37)$$

where R is the gas constant for dry air, $\tilde{T}$ the mean temperature and g the gravity acceleration. H is often called the scale height of the atmosphere.

Now the volume extinction coefficients are simply:

$$\beta_M=\tau_M/H \qquad (4.38)$$

$$\beta_R=\tau_R/H \qquad (4.39)$$

$$\beta_a=\tau_a/H \qquad (4.40)$$

At this point two arguments might be put forward against the introduction of a constant density atmosphere:

Firstly, it might be argued that the choice of any other density, e.g. $\rho=\gamma\rho(z=0)$, would have led to a height H/γ. A brief check of the matrix and vector elements (equations 4.9 to 4.15) shows that the factor γ would equally appear in all of them so the system of differential equations would essentially be the same except for the fact that any height z would now correspond to a height z/γ. To avoid this problem all heights have to be measured in terms of the finite height of the atmosphere H. This procedure is similar to the introduction of pressure coordinates.

Secondly, it might be conjectured that the atmospheric radiation field would be different (in terms of the newly defined relative height coordinates, or in terms of pressure coordinates) for different density-height functions. This is certainly not true as all absorption and scattering processes are independent of each other and the total amount of absorption and scattering depends only on the total amount of absorbers and scatterers in the atmosphere.

The limitations of the independence of the amount of absorbed and scattered radiation on the density-height function are the following: For very high densities Rayleigh and Mie scattering theories are not applicable as they are based on the far field solution of dipole radiation. For very low densities the sphericity of the terrestrial atmosphere would bring about different radiation fields.

To calculate H, an atmospheric mean temperature $\tilde{T}$ has to be found for Resolute. From Palmén and Newton (1969,p.3) a density weighted mean temperature of the atmosphere at 75°N can be calculated as being 233K in January and 253K in July. To interpolate for the intermediate months a simple cosine function was used giving the following results:

month	J	F	M	A	M	J	J	A	S	O	N	D
T (K)	233	234	238	243	248	252	253	252	248	243	238	234

There is one more problem with the calculation of the volume extinction coefficients β. Formulas 4.38 to 4.40 suggest that the coefficients β can directly be obtained from the respective optical depths τ which, in turn, can be obtained from the respective transmissivities T, i.e.,

$$T=\exp(-\tau m)=\exp(-\beta Hm) \tag{4.41}$$

or solved for β

$$\beta=-\frac{1}{Hm}\ln(T) \tag{4.42}$$

Here, m describes the optical air mass or the diffusivity factor, according to the type of radiation.

But formula 4.41, commonly known as Beer's law, is, strictly speaking, only applicable for monochromatic radiation. As the direct beam transmissivities for the entire solar spectrum T of Rayleigh scattering and water vapor absorption are well known (see Section 3.2) we can insert some values into equation 4.42 and find that β_R and β_w are not constant but decrease with increasing optical air mass m. For H=7100m (corresponding to $\tilde{T}$=243K) and 2.3mm of precipitable water (a typical value at Resolute) we find:

m	1	2	5	10	15
$\beta_R(10^{-5}m^{-1})$	1.53	1.27	0.93	0.69	0.57
$\beta_w(10^{-5}m^{-1})$	0.91	0.57	0.31	0.19	0.14

The β-values calculated with equation 4.42 are thus only averages over the entire path length m.

The reason for the β-factors to decrease with increasing air mass is the following: Water vapor absorption is highly selective, i.e., it occurs only in certain spectral bands. Rayleigh scattering, although it is not selective, behaves in a similar way insofar as shorter wavelengths are much more subjected to it than longer ones. The result is similar: After radiation has largely been extinguished in the spectral regions preferred by the extinguishing processes only little is left to be attenuated. Therefore β, which is according to equation 2.8 the fraction of radiation absorbed or scattered per unit length, decreases drastically.

As a transmission function T_a for aerosol extinction, similar to the transmission functions T_R for Rayleigh scattering and T_w for water vapor absorption, could not be found, equation 4.40 was used to calculate β_a.

4.4.3 Rayleigh volume scattering coefficient

Equation 4.42 can be used to determine the Rayleigh volume scattering coefficient β_R for direct solar radiation in the source function (equations 4.13 to 4.15). But a considerable error would be introduced if the same were taken in the elements of the matrix a_{ij} describing the diffuse radiation fluxes. This is due to the fact that diffuse radiation has a completely different spectral composition than direct radiation.

Kondratyev (1969,p.364) gives the theoretically calculated spectrum of downwelling diffuse radiation in a cloudless atmosphere. The mean Rayleigh scattering coefficient $\beta_R^{\downarrow}$ for this spectrum can then be calculated as

$$\beta_R^{\downarrow}=\varepsilon(\sum_i I_i/\lambda_i^4)/\sum_i I_i=\varepsilon\langle 1/\lambda^4\rangle \tag{4.43}$$

where the summation goes over a finite number of spectral intervals i, I_i is the spectral flux in arbitrary units of the interval centered at λ_i and ε is a constant which can be calculated from the information given by Paltridge and Platt (1976,p.119f) as being

$$\varepsilon=1.05*10^{-30}(273/\tilde{T})(p/100)m^3 \tag{4.44}$$

$\langle 1/\lambda^4\rangle$ turns out to be $4.36*10^{25}m^{-4}$ so that $\beta_R^{\downarrow}$ becomes

$$\beta_R^{\downarrow}=4.56*10^{-5}(273/\tilde{T})(p/100)m^{-1} \tag{4.45}$$

$\tilde{T}$ and p are the surface temperature in K and the surface pressure in kPa, respectively.

To calculate $\beta_R^{\uparrow}$, the Rayleigh volume scattering coefficient for upwelling diffuse radiation, we assume that upwelling diffuse radiation at any height z is exclusively composed of downwelling global radiation reflected at the ground and that the ground is a grey reflector. Now we have to trace two radiation fluxes: the flux consisting of reflected direct radiation and the flux consisting of reflected diffuse radiation. The first of these two fluxes traverses the air mass m before it reaches the ground and the air mass $m\uparrow$ from the ground back to the top of the atmosphere. Therefore, its transmissivity on its way back up through the atmosphere is given by

$$T_R(m+m\uparrow)/T_R(m) \tag{4.46}$$

and thus its respective volume scattering coefficient is given by (see equation 4.42):

$$\beta_R^{\uparrow(dir)} = -\frac{1}{Hm\uparrow}\ln\frac{T_R(m+m\uparrow)}{T_R(m)} \tag{4.47}$$

where the superscript (dir) denotes its relation to reflected direct radiation.

The second of these fluxes has a spectral composition which is identical to the spectral composition of downwelling diffuse radiation; therefore

$$\beta_R^{\uparrow(dif)} = \beta_R^{\downarrow} \tag{4.48}$$

where (dif) denotes reflected diffuse radiation.

Now $\beta_R^{\uparrow}$ is just the flux weighted mean of $\beta_R^{\uparrow(dir)}$ and $\beta_R^{\uparrow(dif)}$

$$\beta_R^{\uparrow} = \frac{I\beta_R^{\uparrow(dir)} + D\downarrow\beta_R^{\uparrow(dif)}}{I + D\downarrow} \tag{4.49}$$

4.4.4 Water vapor volume absorption coefficient

Equation 4.42 can also be used to determine the water vapor volume absorption coefficient β_w for direct solar radiation in the source function.

To calculate $\beta_w^{\downarrow}$ for downwelling diffuse radiation the assumption is made that the scattering processes which generate $D\downarrow(z=0)$ take place at $z=H/2$ so that it has to traverse an air mass of $(m+m\downarrow)/2$. Then equation 4.42 can be used giving

$$\beta_w^{\downarrow} = -\frac{1}{H\,\frac{1}{2}(m+m\downarrow)} \ln T_w\left(\tfrac{1}{2}(m+m\downarrow)\right) \tag{4.50}$$

For the computation of $\beta_w^{\uparrow}$, the water vapor volume absorption coefficient for upwelling diffuse radiation, the separation of the two fluxes made in Section 4.4.3 gives

$$\beta_w^{\uparrow(dir)} = -\frac{1}{Hm\uparrow} \ln \frac{T_w(m+m\uparrow)}{T_w(m)} \tag{4.51}$$

$$\beta_w^{\uparrow(dif)} = -\frac{1}{Hm\uparrow} \ln \frac{T_w\left(\frac{1}{2}(m+m\downarrow)+m\uparrow\right)}{T_w\left(\frac{1}{2}(m+m\downarrow)\right)} \tag{4.52}$$

and finally

$$\beta_w^{\uparrow} = \frac{I\beta_w^{\uparrow(dir)} + D\downarrow\beta_w^{\uparrow(dif)}}{I + D\downarrow} \tag{4.53}$$

Results of the Kondratyev-model and the 1.66-model will be given in the end of this chapter.

4.5 Extension to a two-layer atmosphere

It has already been mentioned that the assumption of constant mixing ratios of aerosol and water vapor throughout the depth of the atmosphere is not justified, as the higher layers of the atmosphere don't usually contain much of these attenuating substances. A vertical profile of the aerosol concentration is not available on any regular basis but, as a first estimate, the atmosphere can be divided into two layers of equal mass, and the percentage of aerosol and water vapor in each of these layers can be estimated using commonly accepted values.

The calculational procedures for a two-layer atmosphere are basically the same as for a one-layer atmosphere, the only difference being that all calculations have to be made separately for each layer. All variables pertaining to the upper part of the atmosphere shall hereinafter be marked with a prime. There are now four arbitrary constants, so the same number of boundary conditions has to be found. The two new ones arise from the condition that the upwelling as well as the downwelling diffuse flux must be continuous at the interface of the two layers (see, e.g., Shettle and Weinman, 1970; Weinman and Guetter, 1972; Liou, 1975).

This yields the following set of equations:

$$D'{\downarrow}(z=H)=0 \tag{4.54}$$

$$D{\uparrow}(z=0)=a(D{\downarrow}(z=0)+I(z=0)) \tag{4.55}$$

$$D'{\downarrow}(z=H/2)=D{\downarrow}(z=H/2) \tag{4.56}$$

$$D'{\uparrow}(z=H/2)=D{\uparrow}(z=H/2) \tag{4.57}$$

Again we are only interested in $D{\downarrow}(z=0) \equiv D{\downarrow}$:

$$D{\downarrow}=\left(\frac{a_{11}+r_1}{a_{12}}(B_1+D_1)+\frac{a_{11}+r_2}{a_{12}}(B_2+D_2)\right)I_0T_0 \tag{4.58}$$

D_1 and D_2 and all the other functions needed to calculate D_1 and D_2 are identical to equations 4.24, 4.25, 4.28, 4.29, and 4.30.

$$B_2=\frac{G_1H_2-G_3H_1}{G_4G_1-G_3G_2} \tag{4.59}$$

$$B_1=\frac{I_1\,a_{12}}{a_{12}-a(a_{11}+r_1)}-\frac{a_{12}-a(a_{11}+r_2)}{a_{12}-a(a_{11}+r_1)}B_2 \tag{4.60}$$

$$G_1=\frac{a_{11}'+r_2'}{a_{12}'}(\exp(r_2'H/2)-\exp((r_2'-r_1'/2)H)) \tag{4.61}$$

$$G_2=-\frac{a_{11}+r_2}{a_{12}}\exp(r_2H/2)+\frac{a_{12}-a(a_{11}+r_2)}{a_{12}-a(a_{11}+r_1)}\frac{a_{11}+r_1}{a_{12}}\exp(r_1H/2) \tag{4.62}$$

$$G_3=\exp(r_2'H/2)-\frac{a_{11}'+r_2'}{a_{11}'+r_1'}\exp((r_2'-r_1'/2)H) \tag{4.63}$$

$$G_4=-\exp(r_2H/2)+\frac{a_{12}-a(a_{11}+r_2)}{a_{12}-a(a_{11}+r_1)}\exp(r_1H/2) \tag{4.64}$$

$$H_1=I_3-\exp(-r_1'H/2)I_2+\frac{a_{11}+r_1}{a_{12}-a(a_{11}+r_1)}\exp(r_1H/2)I_1 \tag{4.65}$$

$$H_2=I_4-\frac{a_{12}'}{a_{11}'+r_1'}\exp(-r_1'H/2)I_2+\frac{a_{12}}{a_{12}-a(a_{11}+r_1)}\exp(r_1H/2)I_1 \tag{4.66}$$

$I_1 = E_2$ (from equation 4.27) (4.67)

$I_2 = E_1$ (from equation 4.26, but all variables primed) (4.68)

$$\begin{aligned} I_3 = &- \frac{a_{11}' + r_1'}{a_{12}'} \frac{b_1'(a_{11}' + r_2') + b_2' a_{12}'}{r_2' - r_1'} \left(\frac{e^{-F_1' H/2}}{F_1' - r_1'} + \frac{e^{-F_2' H/2}}{F_2' - r_1'} - \frac{e^{-F_3' H/2}}{F_3' - r_1'} \right) \\ &+ \frac{a_{11} + r_1}{a_{12}} \frac{b_1(a_{11} + r_2) + b_2 a_{12}}{r_2 - r_1} \left(\frac{e^{-F_1 H/2}}{F_1 - r_1} + \frac{e^{-F_2 H/2}}{F_2 - r_1} - \frac{e^{-F_3 H/2}}{F_3 - r_1} \right) \\ &+ \frac{a_{11}' + r_2'}{a_{12}'} \frac{b_1'(a_{11}' + r_1') + b_2' a_{12}'}{r_2' - r_1'} \left(\frac{e^{-F_1' H/2}}{F_1' - r_2'} + \frac{e^{-F_2' H/2}}{F_2' - r_2'} - \frac{e^{-F_3' H/2}}{F_3' - r_2'} \right) \\ &- \frac{a_{11} + r_2}{a_{12}} \frac{b_1(a_{11} + r_1) + b_2 a_{12}}{r_2 - r_1} \left(\frac{e^{-F_1 H/2}}{F_1 - r_2} + \frac{e^{-F_2 H/2}}{F_2 - r_2} - \frac{e^{-F_3 H/2}}{F_3 - r_2} \right) \end{aligned} \quad (4.69)$$

$$\begin{aligned} I_4 = &- \frac{b_1'(a_{11}' + r_2') + b_2' a_{12}'}{r_2' - r_1'} \left(\frac{e^{-F_1' H/2}}{F_1' - r_1'} + \frac{e^{-F_2' H/2}}{F_2' - r_1'} - \frac{e^{-F_3' H/2}}{F_3' - r_1'} \right) \\ &+ \frac{b_1(a_{11} + r_2) + b_2 a_{12}}{r_2 - r_1} \left(\frac{e^{-F_1 H/2}}{F_1 - r_1} + \frac{e^{-F_2 H/2}}{F_2 - r_1} - \frac{e^{-F_3 H/2}}{F_3 - r_1} \right) \\ &+ \frac{b_1'(a_{11}' + r_1') + b_2' a_{12}'}{r_2' - r_1'} \left(\frac{e^{-F_1' H/2}}{F_1' - r_2'} + \frac{e^{-F_2' H/2}}{F_2' - r_2'} - \frac{e^{-F_3' H/2}}{F_3' - r_2'} \right) \\ &- \frac{b_1(a_{11} + r_1) + b_2 a_{12}}{r_2 - r_1} \left(\frac{e^{-F_1 H/2}}{F_1 - r_2} + \frac{e^{-F_2 H/2}}{F_2 - r_2} - \frac{e^{-F_3 H/2}}{F_3 - r_2} \right) \end{aligned} \quad (4.70)$$

F_1, F_2, and F_3 are identical to equations 4.28 to 4.30, F_1', F_2', and F_3' are the same as F_1, F_2, and F_3 but with all variables primed.

Again, as D↓ is being measured, equation 4.58 is a very complicated transcendental function in ω_o and can only numerically be solved for it.

4.6 Evaluation of the two-layer model

4.6.1 Vertical distribution of aerosol and water vapor in the atmosphere

Let us for a moment return to an isothermal atmosphere whose density decreases in an exponential way, with H being the scale height of the atmosphere. Let us then assume that the attenuating constituent i (aerosol or water vapor) decreases also exponentially with height, but with a scale height H_i. Let us now calculate the fraction $1-R_i$ of the total amount of the constituent i which can be found in the lower half of the atmosphere:

If $M_i(z)$ denotes the mass of constituent i per height interval dz then the total mass of constituent i in the entire atmosphere is

$$\int_0^\infty M_i(z)dz=M_i(z=0)\int_0^\infty \exp(-z/H_i)dz=H_iM_i(z=0) \qquad (4.71)$$

If our isothermal atmosphere has a temperature of 243K, then H=7100m and the height of the 50kPa surface which separates the upper from the lower half of the atmosphere is found to be at 4900m. Now the total mass of the constituent i between the ground and 4900m can be calculated as

$$M_i(z=0)\int_0^{4900}\exp(-z/H_i)dz=H_iM_i(z=0)(1-\exp(-4900/H_i)) \qquad (4.72)$$

Then the fraction $1-R_i$ of constituent i in the lower half of the atmosphere is simply given by

$$1-R_i=1-\exp(-4900/H_i) \tag{4.73}$$

Some numbers for the ratio R_i are

H_i (m)	1000	1200	1400	2000	2500	3000	3500	4000	7100
R_i	.007	.017	.030	0.09	0.14	0.20	0.25	0.29	0.50

In Chapter 2, H_a for aerosol was found to be approximately 1200m on a worldwide scale and 1400m in Alaska. A value of R_a ranging at around 0.03 should thus describe the situation sufficiently.

The value of H_w for water vapor was empirically related by Reitan (1963) to the surface dewpoint temperature, t_d, as following:

t_d (°C)	0	-5	-10	-15
H_w (m)	2300	2400	2600	2900

For the cases considered at Resolute the surface dewpoint temperature is on the average at around -25°C which gives H_w =3500m by extrapolation and thus R_w=0.25.

It is obvious that the ratios R_i for aerosol and water vapor are only rough estimates. In the consideration of errors at the end of this Chapter this will be taken account of. But it can be seen that the previous assumption of constant mixing ratios throughout the atmosphere is rather unrealistic.

4.6.2 Volume extinction coefficients

The volume extinction coefficients are defined in a way similar to the one-layer atmosphere. Coefficients for the upper layer (primed) and the lower layer (unprimed) have to be distinguished. w is the precipitable water R_a and R_w mean the fraction of aerosol and water vapor, respectively, in the upper half of the atmosphere.

To understand the transmission functions T_w and T_R it must be remembered that the air mass m acts essentially as a magnification factor as far as water vapor transmissivity is concerned. To calculate water vapor transmissivity for one half of the atmosphere the precipitable water content of this half has to be multiplied by m, and not by m/2. In case of Rayleigh scattering, however, which is a function of m only, m/2 rather than m has to be taken to calculate the transmissivity of one half of the atmosphere.

The aerosol volume extinction coefficients for the upper and the lower layer are:

$$\beta_a' = \frac{1}{\frac{H}{2}} R_a \tau_a \qquad (4.74)$$

$$\beta_a = \frac{1}{\frac{H}{2}} (1 - R_a) \tau_a \qquad (4.75)$$

The water vapor volume absorption coefficients for the upper layer are

$$\beta_w' = -\frac{1}{\frac{1}{2}Hm} \ln T_w(R_w wm) \tag{4.76}$$

$$\beta_w'^{\downarrow} = -\frac{1}{\frac{1}{2}H\frac{1}{2}(m+m\downarrow)} \ln T_w(R_w w\tfrac{1}{2}(m+m\downarrow)) \tag{4.77}$$

$$\beta_w'^{\uparrow(dir)} = -\frac{1}{\frac{1}{2}Hm\uparrow} \ln \frac{T_w(w(m+m\uparrow))}{T_w(wm+(1-R_w)wm\uparrow)} \tag{4.78}$$

$$\beta_w'^{\uparrow(dif)} = -\frac{1}{\frac{1}{2}Hm\uparrow} \ln \frac{T_w(R_w wm+(1-R_w)wm\downarrow+wm\uparrow)}{T_w(R_w wm+(1-R_w)w(m\downarrow+m\uparrow))} \tag{4.79}$$

$$\beta_w'^{\uparrow} = \frac{I\beta_w'^{\uparrow(dir)} + D\downarrow\beta_w'^{\uparrow(dif)}}{I + D\downarrow} \tag{4.80}$$

The water vapor volume absorption coefficients for the lower layer are

$$\beta_w = -\frac{1}{\frac{1}{2}Hm} \ln \frac{T_w(wm)}{T_w(R_w wm)} \tag{4.81}$$

$$\beta_w^{\downarrow} = -\frac{1}{\frac{1}{2}Hm\downarrow} \ln \frac{T_w(R_w wm+(1-R_w)wm\downarrow)}{T_w(R_w wm)} \tag{4.82}$$

$$\beta_w^{\uparrow(dir)} = -\frac{1}{\frac{1}{2}Hm\uparrow} \ln \frac{T_w(wm+(1-R_w)wm\uparrow)}{T_w(wm)} \tag{4.83}$$

$$\beta_w^{\uparrow(dif)} = -\frac{1}{\frac{1}{2}Hm\uparrow} \ln \frac{T_w(R_w wm+(1-R_w)w(m\downarrow+m\uparrow))}{T_w(R_w wm+(1-R_w)wm\downarrow)} \tag{4.84}$$

$$\beta_w^{\uparrow} = \frac{I\beta_w^{\uparrow(dir)} + D\downarrow\beta_w^{\uparrow(dif)}}{I + D\downarrow} \tag{4.85}$$

The Rayleigh volume scattering coefficients for the upper layer are

$$\beta_R' = -\frac{1}{\frac{1}{2}Hm} \ln T_R\left(\tfrac{1}{2}m\right) \tag{4.86}$$

$$\beta_R'^{\downarrow} = 4.56 * 10^{-5} (273/\tilde{T}) (p/100) \tag{4.87}$$

$$\beta_R'^{\uparrow(dir)} = -\frac{1}{\frac{1}{2}Hm\uparrow} \ln \frac{T_R(m + m\uparrow)}{T_R(m + \frac{1}{2}m\uparrow)} \tag{4.88}$$

$$\beta_R'^{\uparrow(dif)} = \beta_R'^{\downarrow} \tag{4.89}$$

$$\beta_R'^{\uparrow} = \frac{I\beta_R'^{\uparrow(dir)} + D\downarrow\beta_R'^{\uparrow(dif)}}{I + D\downarrow} \tag{4.90}$$

The Rayleigh volume scattering coefficients for the lower layer are

$$\beta_R = -\frac{1}{\frac{1}{2}Hm} \ln \frac{T_R(m)}{T_R(\frac{1}{2}m)} \tag{4.91}$$

$$\beta_R^{\downarrow} = 4.56 * 10^{-5} (273/\tilde{T}) (p/100) \tag{4.92}$$

$$\beta_R^{\uparrow(dir)} = -\frac{1}{\frac{1}{2}Hm\uparrow} \ln \frac{T_R(m + \frac{1}{2}m\uparrow)}{T_R(m)} \tag{4.93}$$

$$\beta_R^{\uparrow(dif)} = \beta_R^{\downarrow} \tag{4.94}$$

$$\beta_R^{\uparrow} = \frac{I\beta_R^{\uparrow(dir)} + D\downarrow\beta_R^{\uparrow(dif)}}{I + D\downarrow} \tag{4.95}$$

The results of the two-layer two-stream approximations are given in the next section. The diffusivity factors were taken to be 1.66 for reasons which will be explained shortly.

4.7 Results

The calculated medians of ω_o for 288 cases of cloudless skies and all other relevant data available at Resolute calculated with the Davies-Hay model, the Kondratyev-model, the 1.66-model, and the two-layer model are presented in Table 8.

Table 8 shows also the limits within which 68% of all solutions are found. Numerical solutions for ω_o were searched in the interval (-1,4). But solutions could not be found in all 288 cases. The number of solutions found in this interval is also given in Table 8. In some instances, solutions were found outside the interval (0,1) within which ω_o has to be located by definition. The percentage of solutions outside this interval, i.e., the percentage of physically unacceptable solutions, is listed in the following line of Table 8. Finally, the correlation coefficient between ω_o and $\cos\theta$ is presented. This correlation coefficient should be close to zero because any deviation from zero is more probably due to some faulty zenith angle dependence of the transmissivities or the related volume extinction coefficients rather than to any real zenith angle dependence.

The Davies-Hay model is obviously insufficient, as it yields 42% of all solutions outside the interval which is physically meaningful. The scatter of the solutions around the median of 0.95 is also very great and the correlation of -0.19 indicates that ω_o is over-estimated for low zenith

	Davies–Hay model	two–stream approximation			
		one layer		two layers	
		Kondratyev	1.66	R_a=.03 R_v=.25	R_a=.30 R_v=.25
median and 68%–limits	0.95 (+0.30,−0.22)	0.79 (+0.20,−0.15)	0.80 (+0.18,−0.19)	0.93 (+0.11,−0.16)	0.81 (+0.17,−0.17)
number of solutions in (−1,4)	288	276	276	185	261
% of solutions outside (0,1)	42	16	13	23	14
correlation $\omega_0 \leftrightarrow \cos\theta$	−0.19	−0.38	0.06	0.10	0.22

Table 8: Results of ω_0 at Resolute using four different radiation transfer models. (R_a: fraction of aerosol in upper half of the atmosphere; R_v: fraction of water vapor in upper half of the atmosphere)

angles. It is , in fact, the region of low zenith angles which is responsible for most of the solutions well above unity, indicating that the single-scattering approach loses its validity for the sun being close to the horizon. This result was expected.

The two one-layer two-stream models (Kondratyev-model and 1.66-model) give far more realistic solutions, as only as little as about 15% of the solutions are physically unacceptable, and the scatter of the points is considerably less than in the Davies-Hay model. The only major difference between these two models is the $\cos\theta$-correlation coefficient: The Kondratyev-model gives -0.38, which makes it unacceptable, whereas the 1.66-model gives 0.06; thus it is almost independent of the zenith angle. With respect to these criteria the 1.66-model gives the better results.

The two-layer model for R_e=0.03 and R_w=0.25 has the advantage that the scatter of the solutions is lesser than in the one-layer two-stream models, but solutions can be found only for 64% of all cases from which 23% are physically unacceptable. The $\cos\theta$-correlation coefficient has slightly increased to 0.10.

The fact that in the latter model no solutions can be found for one out of three cases needs more consideration: The lack of any solution in the interval (-1,4) indicates physically that, whatever single-scattering albedo is tried, the observed radiation field cannot be matched with the theoretically predicted one. At first, it might be conjectured that complex solutions for the radiation fields $D\uparrow(z=0)$ and $D\downarrow(z=0)$ should also be considered. So let us examine equation 4.18. r becomes complex if

$$(a_{11}-a_{22})^2 < 4(a_{12}a_{21}-a_{11}a_{22}) \tag{4.96}$$

For all two-stream models except the Kondratyev-model there is only one diffusivity factor $m\uparrow = m\downarrow$ and thus $B_a^\uparrow = B_a^\downarrow$. This leads to a second-order inequality in ω_0 with the solutions

$$\omega_0 > (-\beta_R^\downarrow - \beta_R^\uparrow + \sqrt{(\beta_R^\downarrow + \beta_R^\uparrow)^2 - 4\beta_R^\uparrow\beta_R^\downarrow + 4(\beta_w^\uparrow - \beta_w^\downarrow)^2})/4\beta_a(1-B_a) \tag{4.97}$$

$$\omega_0 < -(\beta_R^\downarrow + \beta_R^\uparrow + \sqrt{(\beta_R^\downarrow + \beta_R^\uparrow)^2 - 4\beta_R^\uparrow\beta_R^\downarrow + 4(\beta_w^\uparrow - \beta_w^\downarrow)^2})/4\beta_a(1-B_a) \tag{4.98}$$

Examination of expression 4.98 shows that this inequality can never be fulfilled as the numerator is always negative but ω_0 must always be positive. But expression 4.97 may have a positive numerator. Actually it is positive for

$$(\beta_w^\uparrow - \beta_w^\downarrow)^2 > \beta_R^\downarrow\beta_R^\uparrow \tag{4.99}$$

In Section 4.4.2 the water vapor volume absorption coefficients were introduced as quantities of the order of magnitude of $10^{-6}-10^{-5}\,m^{-1}$. As $\beta_w^\downarrow$ and $\beta_w^\uparrow$ are similar in size their difference is typically $10^{-6}m^{-1}$ and the square of it $10^{-12}m^{-2}$. $\beta_R^\downarrow$ was introduced in Section 4.4.3 as $4.56*10^{-5}m^{-1}$, $\beta_R^\uparrow$ is typically $2-3*10^{-5}m^{-1}$, so $\beta_R^\uparrow\beta_R^\downarrow$ is around $10^{-9}m^{-2}$. Therefore, the neglect of complex solutions, although they are theoretically possible, does certainly not explain the lack of 36% of all solutions.

Another possible explanation is the distribution of aerosol and water vapor in the atmosphere. Calculations have been made for various combinations of R_a and R_w, the fractions of aerosol and water vapor, respectively, in the upper half of the atmosphere. Table 9 shows the results: The upper line in each square indicates the median and the limits within which 68% of all solutions can be found. The second line shows the number of solutions (288 would be the maximum possible) and the third line shows the percentage of solutions which are outside the physically meaningful interval (0,1).

Three features are interesting to note:

Firstly, the median of ω_0 for $R_a = R_w = 0.50$ is 0.69. The one-layer 1.66-model which has inherently the same aerosol and water vapor distribution gives ω_0 of 0.80. The difference is due to the newly defined volume extinction coefficients. Sample calculations with cases of extremely low precipitable water show that approximately one third of the difference of 0.11 is due to the new Rayleigh coefficients the rest must be attributed to the new water vapor coefficients.

Secondly, variation of R_w with R_a being constant does hardly influence the number of solutions. The medians are only slightly lower for higher R_w and vice versa.

R_w R_a	0.15	0.25	0.35	0.50
0.01		0.93(+0.11,−0.16) 175 26		
0.03	0.96(+0.10,−0.17) 178 33	0.93(+0.11,−0.16) 185 23	0.90(+0.11,−0.15) 184 18	
0.10		0.89(+0.14,−0.16) 213 22		
0.20	0.88(+0.16,−0.17) 246 22	0.85(+0.17,−0.16) 247 17		
0.30	0.83(+0.17,−0.16) 262 17	0.81(+0.17,−0.17) 261 14	0.79(+0.17,−0.16) 261 13	
0.40		0.76(+0.18,−0.17) 271 11	0.74(+0.18,−0.16) 269 8	
0.50		0.73(+0.20,−0.18) 277 8		0.69(+0.20,−0.17) 275 6
0.75		0.64(+0.21,−0.19) 280 5		
0.90		0.59(+0.22,−0.19) 279 5		

Table 9: Results of ω_0 from the two-layer two-stream approximation with various fractions of aerosol (R_a) and water vapor (R_w) in the upper half of the atmosphere. The first line in each square gives the median and the range within which 68% of the solutions can be found. The second line gives the number of solutions in the interval (−1,4) and the third line the percentage of solutions outside the interval (0,1).

Thirdly, and probably most important, the number of solutions increases for R_w being constant and R_a increasing from 0.03 to higher values. The number of solutions reaches its maximum at the rather unrealistic value of R_a=0.75 but even for R_a=0.30 261 solutions can be found. This finding is a strong indication that R_a=0.03 is too low for the Arctic. The question that arises now is which value should be taken for R_a . The more R_a exceeds 0.03 the more it deviates from the commonly accepted vertical aerosol distribution, but so much the more it approaches the situation for which all 288 solutions can be found or, in other words, 288 radiation fields can be explained theoretically.

At this point we may remember the problem of calculating the aerosol optical depth from integrating nephelometer measurements of the aerosol volume scattering coefficient (equation 2.14). It was concluded that the aerosol optical depth was low by approximately half an order of magnitude (which corresponds to a factor of 3). This could have been remedied by introducing H_a=3600m rather than H_a =1200m in equation 2.12 which was not done because no foundation could be found in literature.

Assuming now that Shaw's (1975) vertical aerosol distribution for Alaska is not representative of Resolute, and assuming H_a=3600m instead of 1200m we find from equation 4.73 a value of R_a of 0.26 rather than 0.03. R_a =0.26 comes closest to R_a =0.30 in Table 9 which yields already 261 solutions (=91% of the total of 288 cases) from which only

14% are physically meaningless. Therefore, it may be concluded that R_a=0.30 comes closer to reality than R_a=0.03. For the rest of this Chapter we want to accept R_a =0.30 and thus a value of 0.81 as the median of the single-scattering albedo. This result has a larger scatter than the previous result of 0.93 (for R_a =0.03) and even a correlation coefficient of 0.22 (see Table 8). The hourly results are listed in appendix A.

It is interesting to see that this new result is very similar to the result of the one-layer 1.66-model which yielded ω_0=0.80 with a slightly broader scatter but more solutions (276 instead of 261) and a considerably smaller $\cos\theta$-correlation (0.06 instead of 0.22). Thus the introduction of a two-layer model does not give better results than a one-layer model with constant mixing-ratios for aerosol and water vapor, as long as the real values for R_a and R_w are not known.

4.8 Errors and preliminary discussion

For the rest of this Chapter it shall be examined to what degree errors in the variables change the final result of ω_0=0.81.

If R_a deviates from 0.30 by as far as ±0.20 the final result will change by ∓0.08, for a deviation of ±0.10 it will change by ∓0.05 (Table 9). If R_w deviates from its assumed value of 0.25 by ±0.10 the final result will change by only ∓0.02. The accurate knowledge of R_w is not as important as the precise knowledge of R_a.

Table 10 shows how the final result changes if the following errors are assumed for the variables listed below:

-radiation measurements (±5%)

-solar constant (±1%)

-diffusivity factors (1.50 or 2.00, instead of 1.66)

-water vapor volume absorption coefficients(±20%)

-Rayleigh volume scattering coefficients (±10%)

-aerosol volume extinction coefficients (±10%)

-downward and upward to total aerosol scatter ratios (±10%)

-scale height of the atmosphere (±5%)

Beside the 5%-error in radiation measurements and the 1%-error in the solar constant which have a foundation in literature, as mentioned in Chapter 3, similar justifications for the errors of the remaining variables cannot be given.

As the Kondratyev-model gave bad results compared to the 1.66-model the diffusivity factors for isotropic radiation are probably better than those used in the Kondratyev-model. As was mentioned in Section 4.4.1, these isotropic diffusivity factors range between 1.2 and 2.0. But inspection of Kondratyev's diagram (1969,p.19) mentioned earlier shows that limits of 1.5 and 2.0 should under any circumstances be sufficient for the present error limit determination.

variable	error of variable	resultant change in ω_0	error of variable	resultant change in ω_0
measured values of radiation fluxes	−5%	−0.09	+5%	0.12
solar constant	+1%		−1%	
$m\uparrow = m\downarrow = 2.00$	0.34	−0.03		
$m\uparrow = m\downarrow = 1.50$			−0.16	0.01
all water vapor volume absorption coeff.	−20%	−0.02	+20%	0.03
all Rayleigh volume scattering coeff.	+10%	−0.05	−10%	0.04
all aerosol volume extinction coeff.	+10%	−0.01	−10%	0.02
downward and upward to total aerosol scatter ratios	+10%	−0.02	−10%	0.01
scale height of the atmosphere	+5%	+0.00	−5%	+0.00
all the above errors simultaneously		−0.21		0.26

Table 10: Changes in the final result of ω_0 if errors are introduced separately for each variable and then for all variables simultaneously.

Most difficult to justify is the choice of 20% error for the water vapor volume absorption coefficients and of 10% error for the Rayleigh volume scattering coefficients and the aerosol volume extinction coefficients, respectively. A very simple estimation may show that these limits are at least not too low: Let us calculate β_w and β_R for the case m=2.9, w=2.3mm, R_w=0.25, and H=7100m, and for model atmospheres with increasing numbers of layers. Let us, for example, look at the layer which contains or which lies immediately above the 75kPa surface. Then we find for β_w and β_R in an n-layer atmosphere

n	1	2	4	8	16	32	64	128
$\beta_w(10^{-6}m^{-1})$	4.47	3.34	4.14	3.44	3.28	3.13	3.09	3.08
$\beta_R(10^{-6}m^{-1})$	11.36	8.79	9.46	9.08	8.84			

Application of a two-layer atmosphere rather than a multi-layer atmosphere introduces 8% error in β_w and 1% error in β_R for the layer immediately above 75kPa.

The same calculation for the layer containing or lying immediately above 25kPa yields

n	1	2	16	128
$\beta_w(10^{-6}m^{-1})$	4.47	5.60		3.41
$\beta_R(10^{-6}m^{-1})$	11.36	13.92	14.23	

In this case application of a two-layer atmosphere gives 64%

error in β_w and 2% error in β_R.

Excessive errors in β_w occur only for downwelling radiation in the upper half of the atmosphere, due to the fact that even tiny amounts of water vapor induce considerable absorption. In a multi-layer atmosphere β_w would thus rapidly drop from very high values at the top (0kPa) to relatively small values at 50kPa. Therefore, the average value used in the two-layer atmosphere underestimates the real conditions in a very thin layer at the top, but overestimates throughout the rest of the upper half.

As upwelling radiation has already traversed a long path before it gets reflected at the ground, considerable errors in β_w can be excluded. As only two of the six water vapor volume absorption coefficients introduced in equations 4.76 to 4.85 exhibit large errors, and the remaining four are pretty accurate, a 20% overall-error for the β_w-coefficients may be sufficient.

Although the errors in β_R are only about 1-2%, an error of 10% was assumed because the β_R-factors calculated for diffuse radiation according to equation 4.43 depend on the spectral flux data given by Kondratyev which, by no means, have to have general validity.

A 10%-error in β_a was assumed because β_a is directly derived from τ_a which had error bars of approximately 10% in Chapter 3.

A 10%-error for the downward and upward to total scatter ratios corresponds to the difference between various literature values of this quantity as outlined in Section 4.2.

A 5%-error in the scale height H of the atmosphere corresponds to an approximate error of 5% in the determination of an atmospheric mean temperature $\tilde{T}$.

Table 10 shows that the source of greatest error is the uncertainty in radiation measurements. If the computer program is run with all the variables altered in such a way that the errors are additive then a total error of +0.26/-0.21 is the result. As, by definition, $\omega_0 \leq 1.00$ the final result for R_a=0.30 and R_w=0.25 is

$$\omega_0=0.81\ (+0.19,\ -0.21) \tag{4.100}$$

As R_a and R_w are based on estimations rather than on calculations another error has to be investigated. Inspection of Table 9 shows that ω_0 increases for decreasing R_a and decreasing R_w but decreases for increasing R_a and increasing R_w. As the value of 0.30 accepted for R_a is already 10 times greater than the value which has a secure foundation in literature it may be sufficient to consider only values less than 0.30 for the determination of the total error in ω_0. But as the upper error limit of ω_0 has already hit the physically meaningful limit, namely 1.00, any reduction of R_a from 0.30 to lower values does not influence the error limits.

The value of 0.25 accepted for R_w is again more of a maximum possible value than of a mean value for which errors have to be considered into both directions. Going back to Chapter 4.6.1 we extrapolated the water vapor scale height H_w far beyond the values given by Reitan (1963) and, as a result of that, gained H_w=3500m and R_w =0.25. Again, lower values of R_w do not influence the upper error limit as it has already reached 1.00.

We can thus conclude that the aerosol single-scattering albedo at Resolute is 0.81. But under the worst conditions, especially under the condition of radiation measurements being as much wrong as 5%, the single-scattering albedo may take any value greater than 0.60.

With respect to Table 5 an aerosol single-scattering albedo of 0.81 is lower than what can be expected for remote sites but it is higher than what is found close to industrial sites. Any interpretation beyond that cannot be justified with regard to the large error limits.

Unfortunately, the cloudless hours at Resolute are almost exclusively restricted to spring, so a between-season comparison cannot be made. The results given by months are:

month	4/78	5/78	3/79	4/79	4/80	5/80
# of cases	26	17	42	63	81	13
median	0.87	0.84	0.70	0.84	0.80	0.74

The only striking feature in this table is the sharp increase from March to April 1979. But this is probably due to the cosθ-dependence of the result rather than to any real phenomenon, because the cosθ-mean value for March 1979 is 0.21 but for April 1979 it is 0.34.

Further discussion of this result, especially with respect to the question of the origin of the arctic aerosol, has to await the result of the calculation of the aerosol optical depth at the other four stations.

5. Aerosol optical depth at four other arctic stations

5.1 Introduction

So far, the aerosol optical depth and the aerosol single-scattering albedo have only been calculated for Resolute. Resolute was chosen because it is the only Canadian station north of 60°N with regular measurements of the global solar, the diffuse solar, and the reflected solar radiation.

To get a better understanding for the areal and seasonal aerosol turbidity pattern the aerosol characteristics should be determined for other stations. There are thirteen more stations in the Northwest Territories where global solar radiation is being measured. Data for four of them were obtained for further calculations, namely for Alert (82.5°N, 62.3°W) which is the northernmost meteorological station of North America and only some 800km away from the North Pole; for Inuvik (68.3°N, 133.5°W) which is the station closest to Alaska and thus most readily comparable to Barrow, Alaska, where most of the Arctic aerosol research has been centered to date; for Baker Lake (64.3°N, 96.0°W) one of the southernmost stations of the Northwest Territories and one of the few continental ones, and finally for Frobisher Bay (63.7°N, 68.6°W) which is located in the southeasternmost portion of the Northwest Territories and thus closer to the Atlantic

Ocean than any other arctic station (see Figure 1).

Because only one, rather than three, radiation fluxes are measured at these stations two more variables have to be inserted as constants in the governing equations. The lack of reflected solar radiation measurements suggests that the albedo has to be estimated. The lack of diffuse solar radiation measurements necessitates that one of the two variables, aerosol optical depth or aerosol single-scattering albedo, has to be taken as a known constant for the calculations.

From what has been said about these variables it is obvious that the aerosol single-scattering albedo must be taken as a constant, so the models can be solved for the aerosol optical depth. Even at this point a warning must be given that, due to the introduction of two more constants, the results of τ_a for the four other arctic stations are inevitably less accurate than the results of τ_a for Resolute.

5.2 Radiation models

Two radiation models are examined for the purpose of determining the aerosol optical depth τ_a: the Davies-Hay model combining the equations for direct and diffuse radiation and the one-layer two-stream approximation with diffusivity factors of 1.66 and a direct radiation term. As both models describe the radiation fluxes for cloudless skies, only hours with 10/10 sunshine duration and 0/10 cloudiness can be used.

For the aerosol single-scattering albedo ω_0 a constant value of 0.95 was used in the Davies-Hay model and a constant value of 0.80 in the 1.66-model. These values correspond to the results of ω_0 gained for Resolute with the Davies-Hay model and the 1.66-model, respectively.

The appropriate choice of surface albedos needs more extensive discussion: The surface albedo is to a certain degree dependent on the cloudiness of the sky (see, e.g., Wallén, 1948; Maykut and Church, 1973; Petzold, 1977). Therefore, only cloudless hours were taken to determine the albedo at Resolute. As all cloudless hours at Resolute coincide with complete snow cover, only the albedo for the snow cover period could be calculated and was found to be 0.72. At this point it must be remembered that the radiometer is mounted close above the ground. Therefore, this result is only representative of the immediate vicinity of the radiometer. Thus, choosing albedo values representative of the entire Arctic for all seasons requires a brief review of the vast albedo literature.

Beside the usual textbook values for the albedo of a tundra surface in summer and in winter, the following investigations were found for the North American Arctic:

Jackson (1961) reports on helicopter measurements made in Labrador-Ungava. For areas covered by bare rock he found an albedo of 0.08 to 0.12 in summer and 0.70 in winter.

Davies (1965) reports that in the same region a value of 0.15 could be found for the albedo of tundra surfaces in summer. He made also aircraft measurements.

Ground-based measurements at Moosonee (northern Ontario) gave values of 0.17 for summer and 0.72 for winter (Möller, 1965).

Aircraft measurements were made by McFadden and Ragotzkie (1967) over northern Canada. The following results are valid for clear skies: snowcovered tundra 0.89; tundra without snow but with partly frozen lakes 0.25, ...unfrozen lakes 0.11, ...no lakes at all 0.15.

Ground-based measurements in the vicinity of Baker Lake made by Ahrnsbrak (1968) give summer values of the albedo of 0.14 to 0.24.

Wilson and MacFarlane (1969) found that the albedo at Porte-de-la-Baleine (northern Quebec) dropped from 0.85 after a snowfall to 0.77 two weeks later. Measurements were made on ground.

Finally, Maykut and Church (1973) in a study made about Barrow, Alaska, give winter albedos of 0.80 to 0.90 (average: 0.84) and a summer average of 0.18. Measurements were also made on ground.

With these results in mind and knowing that all four stations are in a tundra environment (Canada, Dept. of Energy etc., 1974, p.45f.) it was decided to use 0.80 as the albedo for hours with snowcover, 0.15 for the period without snow, and to omit all occurrences with traces of snow or unknown snow conditions.

Let us now return to the radiation models: One more difficulty arises from the fact that ozone soundings are not available for these stations. Monthly mean values for Resolute for the years 1975, 76, 78, 79, and 1980 were calculated from published ozone data (Canada, Environment Canada etc., 1975ff.) and graphically smoothed to give:

month	J	F	M	A	M	J	J	A	S	O	N	D
ozone ($\frac{1}{100}$ mm)	430	465	470	465	430	385	350	320	300	310	345	390

These mean values compared with daily ozone readings from the ozone stations at Barrow (Alaska), Churchill (Manitoba), and Goose Bay (Newfoundland) indicate that in almost all cases deviations of the real ozone amounts from the amounts given above are less than 20%.

Now all necessary data are available for use in the above-mentioned radiation models.

Addition of equations 3.3, 4.2, 4.3, and 4.4 yields the global solar radiation flux on the ground according to the Davies-Hay model. This equation can immediately be solved for T_a and thus for τ_a. As the equation is of first order there is always one solution except for the cases of negative T_a which are physically meaningless.

In the one layer two-stream approximation the global solar radiation flux on the ground is given by equations 3.3 and 4.21. To solve the sum of these equations numerically for β_a the relation $\tau_a = H\beta_a$ has to be substituted into equation 3.5 and the latter into equation 3.3. Furthermore, as the splitting of the global flux into the direct and diffuse fluxes is not known, a ratio of 2:1 was assumed (which turns out to be quite accurate for many cases at Resolute) to calculate the Rayleigh volume scattering coefficient for upwelling diffuse radiation according to equation 4.49 and the water vapor volume absorption coefficient for upwelling diffuse radiation according to equation 4.53. Numerical solutions for β_a were searched in the interval $(-1*10^{-4}, 2*10^{-4} m^{-1})$ which, multiplied by the atmospheric scale height H, give the aerosol optical depths.

5.3 Results

Both models were applied to all four stations and the following statistical parameters were calculated (Table 11):

- the correlation coefficient between τ_a and the cosine of the solar zenith angle, $\cos\theta$,
- the intercept, $\tilde{a}$, and the slope, $\tilde{b}$, of the regression equation

$$\tau_a = \tilde{a} + \tilde{b} * \cos\theta \qquad (5.1)$$

- the median of τ_a and the range within which 68% of all results of τ_a can be found.

station	model	correlation $\tau_a \leftrightarrow \cos\theta$	$\tilde{a}$	$\tilde{b}$	median and 68% limits of τ_a
Alert (303)	Davies-Hay model	-0.11	0.125	-0.078	0.100 (+0.054,-0.056)
	1.66-model	-0.04	0.099	-0.016	0.092 (+0.034,-0.034)
Inuvik (745)	Davies-Hay model	0.23	0.068	0.093	0.087 (+0.074,-0.042)
	1.66-model	0.62	0.052	0.182	0.117 (+0.050,-0.052)
Baker L. (324)	Davies-Hay model	0.00	0.082	-0.001	0.078 (+0.056,-0.058)
	1.66-model	0.44	0.047	0.121	0.082 (+0.061,-0.042)
Frobi. B. (394)	Davies-Hay model	0.18	0.084	0.057	0.098 (+0.056,-0.045)
	1.66-model	0.59	0.052	0.140	0.102 (+0.045,-0.042)

Table 11: The correlation coefficient as well as the regression constants, $\tilde{a}$ and $\tilde{b}$, of the regression τ_a vs. $\cos\theta$, and the medians and 68% limits for τ_a calculated with two different radiation models at four arctic stations. The number in brackets behind each station name indicates the number of observations.

Let us first look at the correlation between τ_a and $\cos\theta$. The Davies-Hay model yields small correlations whereas the 1.66-model gives correlations of up to 0.62. It is conceivable that this high positive correlation represents a seasonal march of τ_a with high values in summer and low values in winter. But inspection of the data shows that a strong $\cos\theta$ -dependence of τ_a can also be found on a daily basis. As it is very unlikely that τ_a increases in the forenoon and decreases in the afternoon the $\cos\theta$-dependence or at least a big portion of it is due to a weakness of the radiation model. So the simpler Davies-Hay model gives more reliable results.

If it is assumed that even the $\cos\theta$-dependence of the Davies-Hay model is faulty then the maximum error due to this dependence can be estimated using the regression coefficients: The lowest monthly mean values of $\cos\theta$ are found to be 0.1 and the highest ones, e.g. in Inuvik, are around 0.5. For Inuvik the monthly τ_a mean values would then be $0.068+0.1*0.093 = 0.077$ and $0.068+0.5*0.093 = 0.115$, respectively. In other words, under the worst circumstances, an amount of $0.115-0.077 = 0.038$ of the difference of τ_a between summer and winter months would be due to the erroneous $\cos\theta$-dependence of the final result. But, as will be seen shortly, the differences betwen months are in many cases much greater than 0.038 and in some cases the low τ_a mean values can be found together with high $\cos\theta$ mean values and vice versa. Furthermore, inspection of Table 11 shows that Baker Lake has no $\cos\theta$-dependence at all, and Alert has even a negative $\cos\theta$-dependence. If the Davies-Hay model really contained an erroneous $\cos\theta$-dependence it should be found at all stations. Therefore, it may be concluded that the Davies-Hay model is largely free of any systematic error due to the solar zenith position.

Table 11 shows also that the medians gained for two stations using the two different models are very similar, namely for Baker Lake and Frobisher Bay. The two numbers in brackets give the range within which 68% of all results can be found. The Davies-Hay model gives slightly larger ranges. This need not necessarily be a disadvantage as certain seasonal changes in τ_a should be expected.

For the rest of this Chapter the results calculated with the Davies-Hay model will be used.

The Davies-Hay model with fixed values for the surface albedo and the aerosol single-scattering albedo was used to recalculate τ_a for Resolute. This procedure yielded a correlation between τ_a and $\cos\theta$ of 0.27 as compared to 0.24 from the direct radiation calculations of Chapter 3. The median and the 68%-limits for all cloudless hours amount to 0.103 (+0.095, -0.062) as compared to 0.087 (+0.052, -0.030) from the direct radiation model. It seems that the Davies-Hay model slightly overestimates τ_a. This should be kept in mind to compare the results from the four global radiation stations with the result from Resolute.

Tables 12 to 15 show the monthly medians for τ_a calculated with the Davies-Hay model for Alert, Inuvik, Baker Lake, and Frobisher Bay, respectively. The line under each median indicates the 68%-range. Results are given only for months with at least ten single results or with results stemming from at least three different days. The tables will be commented in Section 5.5. Appendix B contains the hourly input and output data for these stations.

5.4 Errors in the results

The Davies-Hay model contains several variables with considerable inaccuracies. They have to be subjected to an error analysis.

First of all, an error of 5% has to be assumed for the global radiation measurements and an error of 1% for the solar constant (see Chapters 3 and 4).

An error of 10% is assumed for the upward and downward to total aerosol scatter ratios as in Chapter 4.

For the ozone content an error of 20% was taken corresponding to the findings outlined in Section 5.2.

For the surface albedo the lower error limit was taken to be 0.05 in summer and 0.65 in winter, and the upper error limit was taken as being 0.30 in summer and 0.90 in winter. All albedo investigations mentioned in Section 5.2 fall into these limits.

	1978	1979	1980
J			
F			
M		0.06 (+0.04,−0.05)	0.17 (+0.06,−0.17)
A	0.11 (+0.04,−0.06)	0.14 (+0.04,−0.07)	0.09 (+0.07,−0.04)
M	0.11 (+0.03,−0.04)	0.13 (+0.03,−0.05)	0.09 (+0.03,−0.08)
J	0.10 (+0.04,−0.07)		0.11 (+0.07,−0.07)
J	0.06 (+0.04,−0.03)	0.04 (+0.03,−0.04)	0.05 (+0.23,−0.02)
A	0.08 (+0.00,−0.01)	0.04 (+0.02,−0.03)	
S			
O			
N			
D			

Table 12: Monthly medians of τ_a at Alert. The numbers in brackets indicate the 68% range of τ_a.

	1978	1979	1980
J			
F	0.05 (+0.02,−0.06)	0.05 (+0.05,−0.02)	
M	0.07 (+0.01,−0.02)	0.15 (+0.05,−0.07)	0.06 (+0.01,−0.02)
A	0.16 (+0.06,−0.07)	0.14 (+0.06,−0.03)	0.07 (+0.01,−0.02)
M	0.22 (+0.13,−0.12)	0.04 (+0.02,−0.01)	0.07 (+0.04,−0.05)
J	0.07 (+0.03,−0.02)	0.07 (+0.02,−0.02)	0.12 (+0.03,−0.05)
J	0.09 (+0.02,−0.03)	0.09 (+0.09,−0.03)	0.10 (+0.02,−0.06)
A	0.10 (+0.02,−0.03)	0.09 (+0.01,−0.01)	0.13 (+0.03,−0.03)
S	0.08 (+0.02,−0.01)		0.12 (+0.03,−0.02)
O	0.17 (+0.06,−0.25)		
N			
D			

Table 13: Monthly medians of τ_a at Inuvik. The numbers in brackets indicate the 68% range of τ_a.

	1978	1979	1980
J	0.04 (+0.05,−0.08)	0.05 (+0.05,−0.03)	
F	0.05 (+0.02,−0.04)	0.08 (+0.04,−0.04)	
M	0.10 (+0.15,−0.04)		
A	0.08 (+0.06,−0.07)		
M	0.05 (+0.11,−0.08)		
J			
J	0.08 (+0.06,−0.04)		
A	0.12 (+0.02,−0.01)		
S			
O			
N	0.07 (+0.02,−0.03)		
D			

Table 14: Monthly medians of τ_a at Baker Lake. The numbers in brackets indicate the 68% range of τ_a.

	1978	1979	1980
J			
F	0.07 (+0.02,−0.02)	0.08 (+0.07,−0.03)	0.13 (+0.01,−0.09)
M	0.14 (+0.05,−0.05)	0.12 (+0.04,−0.04)	0.12 (+0.01,−0.05)
A	0.09 (+0.05,−0.04)	0.07 (+0.06,−0.08)	
M	0.12 (+0.05,−0.03)		0.18 (+0.08,−0.05)
J			
J		0.07 (+0.03,−0.06)	0.10 (+0.01,−0.04)
A	0.13 (+0.02,−0.03)		
S			0.11 (+0.03,−0.01)
O			
N		0.06 (+0.01,−0.05)	
D			

Table 15: Monthly medians of τ_a at Frobisher Bay. The numbers in brackets indicate the 68% range of τ_a.

Finally, for the single-scattering albedo the limits were taken as 0.80 and 1.00. It must be remembered that the Davies-Hay model gave a value of 0.95 for ω_0 at Resolute, so 0.80 represents a considerable negative deviation. A value of 1.00 is the upper limit which is meaningful.

A justification that the errors of the other variables in the Davies-Hay model are negligible was given earlier.

Table 16 shows how the median of τ_a for Alert, which is 0.100, changes if these errors are introduced separately. The lower part of Table 16 shows what happens to the medians of all four stations after all errors are introduced simultaneously so that they are additive. It turns out that these total errors are huge. The negative error deviations have approximately the sizes of the medians themselves (see Table 11) and the positive deviations have even about twice the sizes of the medians. In other words, if the median of τ_a for a station is called m then the total error analysis suggests that the real median is located somewhere between 0 and 3m. As the medians are around 0.1 this result means that the error bars have to be extended from about $\tau_a = 0.0$ to about $\tau_a = 0.3$ which makes the results completely meaningless.

But inspection of Table 11 shows that the medians of the four stations are very similar, namely 0.100, 0.087, 0.078, and 0.098, respectively. If the error bars were as large as indicated in the last paragraph it would be very unlikely to get results of such close similarity. Table 16

variable	error of variable	resultant change in τ_a	error of variable	resultant change in τ_a
measured values of global radiation	+5%	−0.057	−5%	0.066
solar constant	−1%		+1%	
downward and upward to total aerosol scatter ratios	+10%	−0.002	−10%	0.002
ozone content	+20%	−0.008	−20%	0.007
surface albedo in summer 0.05/0.30	−0.10	−0.018	+0.15	0.013
surface albedo in winter 0.65/0.90	−0.15		+0.10	
single−scattering albedo 0.80/1.00	−0.15	−0.026	+0.05	0.011
all these errors simultaneously at:				
Alert		−0.077		0.138
Inuvik		−0.073		0.131
Baker Lake		−0.075		0.155
Frobisher Bay		−0.087		0.197

Table 16: Changes in the final result of τ_a if errors are introduced separately for each variable at Alert (upper part) and if all errors are introduced simultaneously so that they are additive at Alert, Inuvik, Baker Lake, and Frobisher Bay, respectively (lower part).

shows that by far the biggest portion of the total error originates from the assumption that the error that has to be applied for global radiation measurements is as big as 5%. This error is also responsible for a large fraction of the total error of the aerosol single-scattering albedo in Chapter 4.

With a considerable degree of confidence the following two conclusions may thus be drawn:

Firstly, a 5% error in the radiation measurements is too pessimistic.

Secondly, the errors in τ_a are considerable. An intercomparison of the absolute τ_a-values between the stations is not justified. But as the errors due to a badly calibrated pyranometer or due to an over- or underestimation of the other variables are systematic, i.e., do usually not change sign and extent over time, an intercomparison between the seasons at a given station is feasible if the interseasonal change is considerable and occurs regularly each year.

5.5 Discussion of the results

The medians for Alert (Table 12) show one pronounced feature, namely a relatively high aerosol optical depth in the first half of the year and then, approximately in July, a sharp drop to values about half as great as before July. The maximal aerosol turbidity occurs betwen March and May and its extent is variable from year to year. The low values for March 1979 may indicate that the period of high aerosol turbidity does not extend all through winter but is confined to several months in spring. An influence of the eruption of Mt. St. Helens cannot be found for July 1980 suggesting that the 'aerosol cloud' has not arrived there before the end of July.

The results for Inuvik (Table 13) show a similar periodic change of aerosol turbidity. As more values are available in Inuvik for the months of February and March it becomes obvious that the occurrence of high aerosol turbidity is confined to a short period of about two months in spring. Its onset is variable from year to year but high aerosol turbidity may not even occur at all as in 1980. The sharp drop from high to low aerosol turbidity occurs earlier in the year than in Alert, namely already in May and June. After an apparent midsummer mimimum aerosol turbidity rises again to higher values in late summer and early fall of 1978 and 1979. From June to September 1980 aerosol turbidity is higher than in the previous years which may be due to Mt. St. Helens.

For Baker Lake (Table 14) values were unfortunately available for only 14 months. But these data are enough to show the same feature that was observed in Inuvik: After very low winter aerosol turbidities there is a two month maximum in March and April. The second maximum in late summer is, in the case of Baker Lake, more pronounced than in Inuvik and is at least of the same magnitude as the spring maximum.

Finally, the seasonal pattern at Frobisher Bay (Table 15) is to a lesser degree periodic than at the other three locations. 1978 shows a very short but intensive maximum in March, a minimum in April and high values thereafter. In 1979 only the short and pronounced March maximum can be found again. The entire year 1980 shows high aerosol turbidities. The May maximum occured before the eruption of Mt. St. Helens on May 18th, 1980.

At this point it should be remembered that the typical spring maximum was also found at Resolute (Chapter 3) which is thus a common feature for the entire Canadian Arctic.

In the last Chapter the conclusion was drawn that, due to the large errors, an intercomparison of the absolute magnitudes of aerosol turbidity between the stations is not feasible. But as annual medians were found to be very similar at all five stations, namely $\tau_a = 0.09 \pm 0.01$, this value may be compared with the results from other authors given in Tables 1 to 3:

The results of this thesis are in good agreement with other τ_a-measurements in the Arctic but not with τ_a-values calculated from integrating nephelometer readings in the Arctic. The aerosol optical depth in the Canadian Arctic is lower than in most parts of the midlatitudes but is distinctly higher than in Antarctica.

5.6 Interpretation of the results and conclusion

The purpose of this thesis was to calculate the aerosol optical depth and the aerosol single-scattering albedo from radiative transfer models at several stations in the Canadian Arctic in order to contribute to the knowledge of the areal and seasonal extent of the aerosol turbidity and to the question of its origin.

This final discussion will deal with three questions:

-Are the radiative transfer models used sufficient for this purpose?

-Are there common characteristics of the aerosol turbidity in the Canadian Arctic?

-Where does the arctic aerosol come from?

As for the radiative transfer models the following must be stated: Integrating nephelometer measurements made in the surface boundary layer are insufficient for determining the seasonal characteristics of the entire atmosphere. Therefore, models for the transfer of radiation through the entire atmosphere have to be applied.

The direct solar radiation model used to determine τ_a at Resolute is indispensible, as no serious alternative exists. The single-scattering model (Davies-Hay model) and the multiple-scattering model (two-stream approximation in a one-layer atmosphere, or 1.66-model) are not interchangeable as the first one has to be taken to calculate τ_a from global radiation fluxes and only the latter one can be used to determine the aerosol single-scattering albedo. In other words, Davies and Hay (1980) have developed the single-scattering model to such a perfection that it is now a competitor with the simplest versions of multiple-scattering approximations. Application of models with more than one layer is not justified as long as the vertical profile of absorbers and scatterers has to be taken from literature values which claim general global applicability.

The major stumbling-block for the application of any radiation model, as sophisticated as it may be, is the fact that a large error has to be taken into account for the radiation measurements. But the results of Chapter 5 point out that the generally accepted error of 5% is most probably too pessimistic. All error bars in this thesis are thus too large. It is a necessity to reassess the inaccuracy of the radiation measurements performed by the Atmospheric Environment Service with the aim of giving more realistic error limits for empirical radiation studies of this kind.

Even with errors of 5% of the measured radiation the results can be used to find certain seasonal characteristics of the aerosol optical depth. The most outstanding feature is a period of high aerosol turbidity in spring which does not last longer than three months. In the northern and western Arctic the aerosol turbidities in summer are about half as great as during the spring maximum. The stations in the southern and especially in the southeastern parts of the Northwest Territories show a secondary period of high aerosol turbidity in late summer. Due to heavy cloudiness in fall and due to the polar night in winter not many results could be gained for these seasons. But, from the few data available, winter seems to be a period of low aerosol turbidity. This result does not support the assertions of various researchers who, by making only few measurements, claim that winter is the period of high and summer the period of low aerosol turbidity.

The results gained in this thesis rather suggest that three regimes are interfering:

Firstly, the background aerosol regime which amounts to about $\tau_a = 0.05$ and is comparable in size to the aerosol turbidity of the remotest place on Earth: Antarctica.

Secondly, there is a spring regime which doubles or triples or even quadruples the aerosol turbidity for several weeks in spring. The data of 1978 and 1979 show that it occurs in the southern and eastern portions of the Northwest Territories earlier than it does in the northern and western portions. As the Arctic is almost unpopulated and there is continuous snowcover throughout the Canadian Arctic in spring the aerosol must be imported. But it must not be concluded that the 'aerosol cloud' moves in a southeasterly flow over the Arctic as the mean flow would be capable of distributing the 'aerosol cloud' in much less time than one or two months.

Thirdly, there is a summer regime which affects only the southern and eastern parts of the Northwest Territories.

This regime is essentially the same regime that is responsible for the midlatitudinal summer maximum (see the first lines of Table 1). It is due to the fact that any surface free of snow is a potential aerosol source, especially in combination with the occurrence of convective storms. In the case of the Arctic it may also be due to forest fires in the adjacent boreal forests.

With respect to what was said in Chapter 2 about the origin of the arctic aerosol, a plausible explanation for the short but intensive spring maximum seems to be the duststorm hypothesis. As duststorms do not only occur in the semi-deserts and deserts of central Asia it should be worthwhile investigating whether dust from similar occurrences on the North American prairies can reach the Canadian Arctic during spring.

The lengthy determination of the single-scattering albedo did unfortunately not contribute conclusively to the solution of the problem of the aerosol's origin. This is so because the final result of 0.81 does not clearly indicate whether the aerosol is typically a natural one or typically a man-made one. The large error bar of the final result is further aggravating its interpretability.

Furthermore, a warning should be issued at this point against the use of the aerosol single-scattering albedo as a clearcut indicator of the aerosol's origin. This has three reasons:

Table 5 showed already that desert dust storms may produce relatively low single-scattering albedos due to the fact that dried and ground remnants of plants behave optically like man-made aerosols. The same is true for ashes from forest fires. Although some efforts have been made to determine the imaginary part of the refractive index for various substances (see Chapter 2) the same attention should also be given to the determination of the single-scattering albedo of these substances because the latter can be calculated from the former only if the particle size-distribution is known (see Figure 2). It should be kept in mind that it is the single-scattering albedo which is ultimately the variable used in many radiation and even global climatic models.

The second reason why the aerosol single-scattering albedo is not an optimal tracer for aerosols is the fact that the particle size-distribution undergoes changes with the ageing of an aerosol. Mie theory shows that the scattering and absorption cross-sections of a dielectric sphere change rapidly when the radius of the sphere increases. Therefore, with the change of a particle size-distribution a change of the ratio of the total absorption cross-section to the total scattering cross-section per unit mass of aerosol occurs and thus the single-scattering albedo changes.

Another reason why the aerosol single-scattering albedo might be changeable is its dependence on relative humidity

(Hänel, 1976). As this dependence is only important for relative humidities greater than 80% it affects a small portion of the entire data set used. But in general it has to be considered, too.

2

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Appendix A: Data for Resolute

The columns have the following meaning:

1: line number

2: year

3: month

4: day

5: hour

6: global solar radiation (kJ/m^2hour)

7: diffuse solar radiation (kJ/m^2hour)

8: reflected solar radiation (kJ/m^2hour) (****: missing)

9: ozone (cm NTP)

10: precipitable water (cm liquid)

11: station pressure (KPa)

12: station temperature (°C)

13: cloudiness (tenths)

14: relative humidity (%)

15: visibility (km)

16: wind direction (degrees) (0: calms)

17: cosine of the solar zenith angle

18: ozone transmissivity

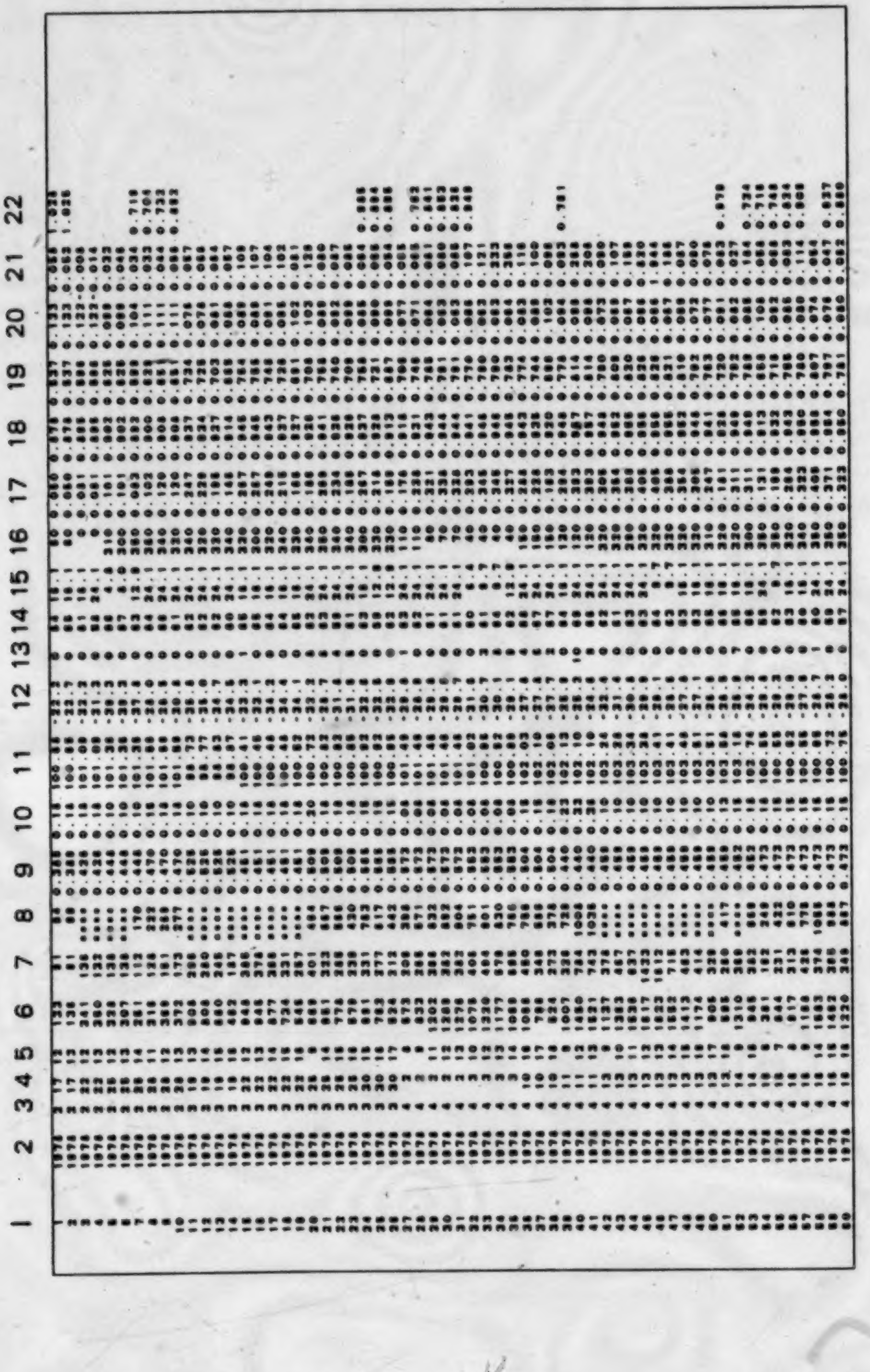
19: Rayleigh transmissivity

20: water vapor absorptivity

21: aerosol optical depth

22: aerosol single-scattering albedo

Resolute



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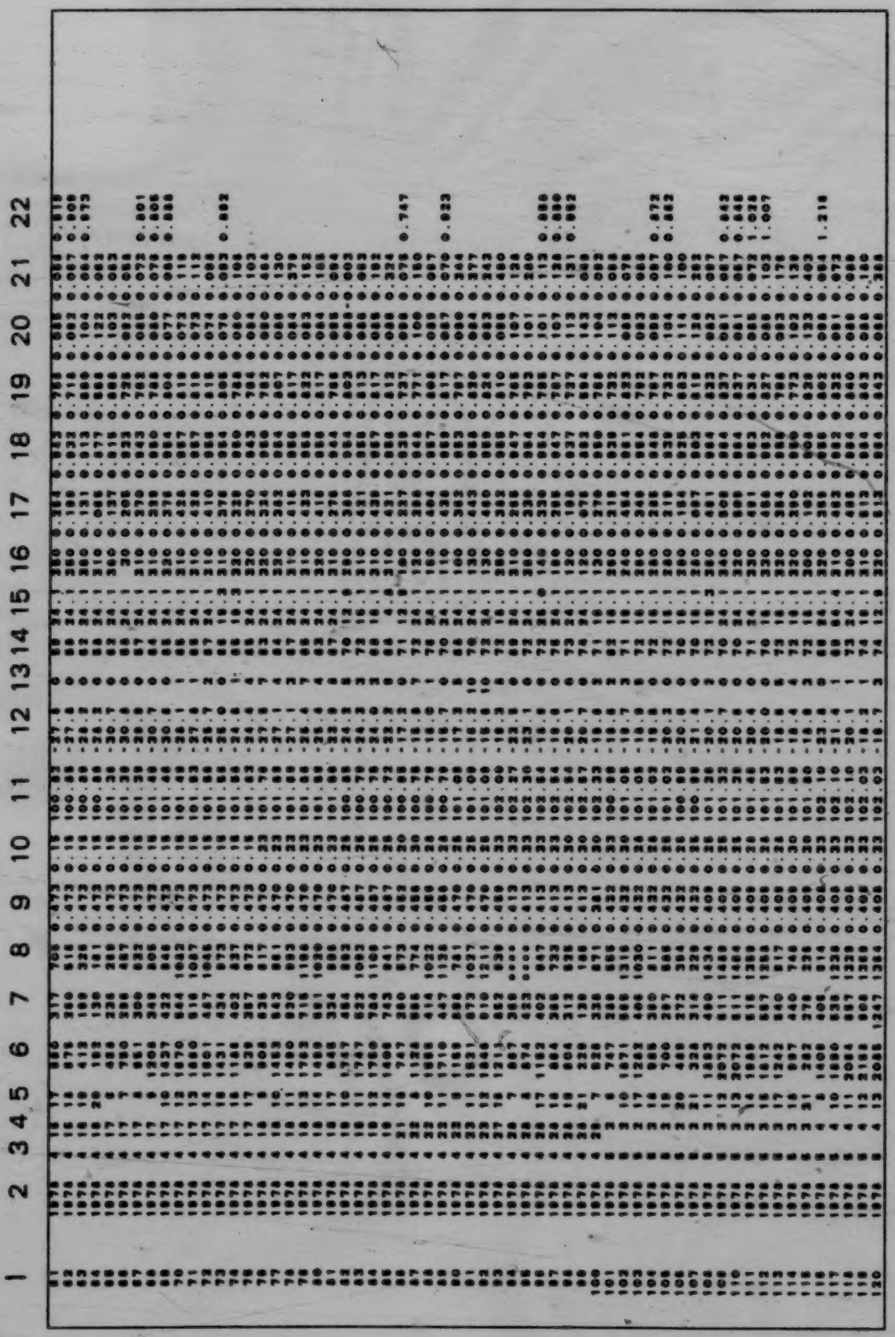
Resolute



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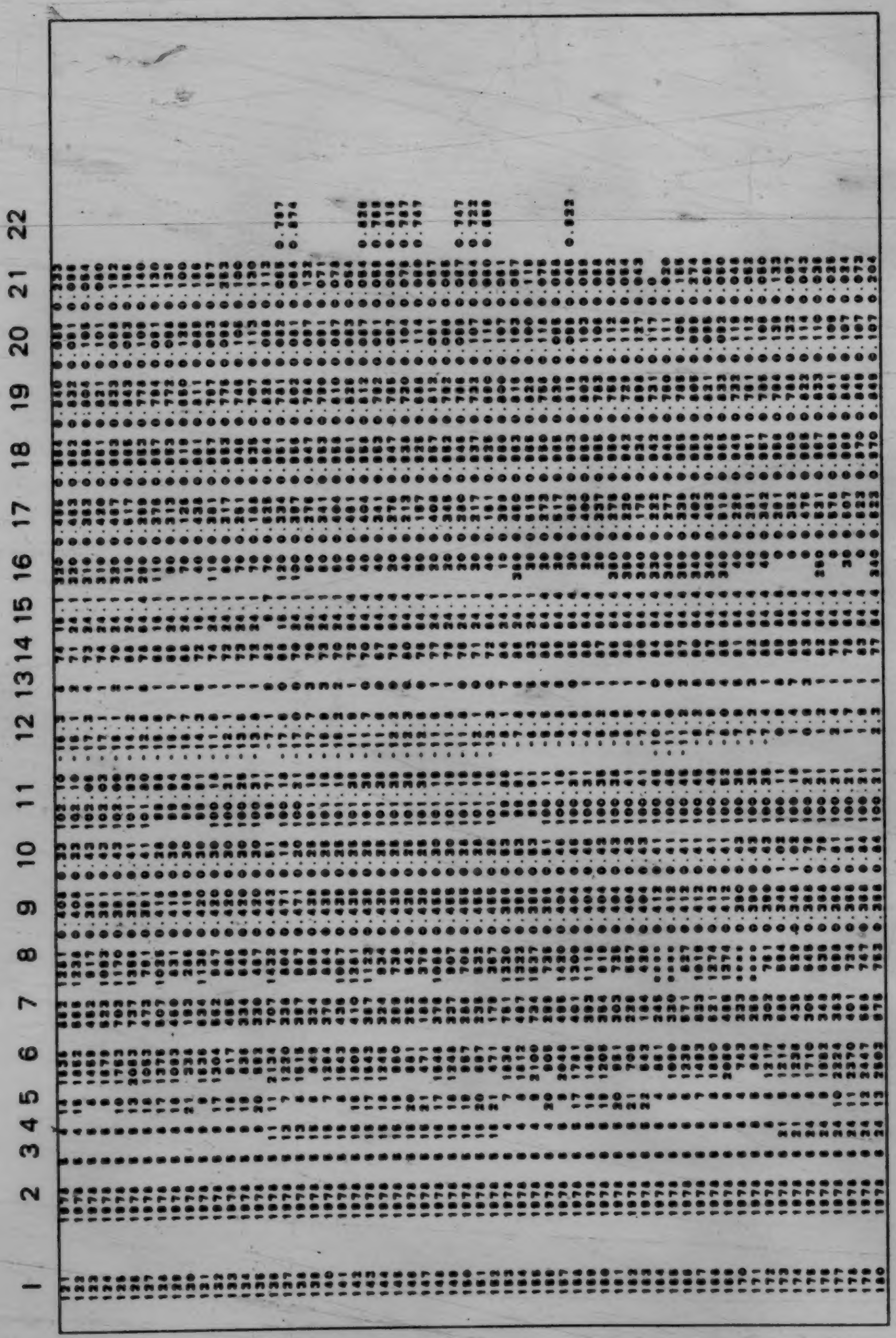

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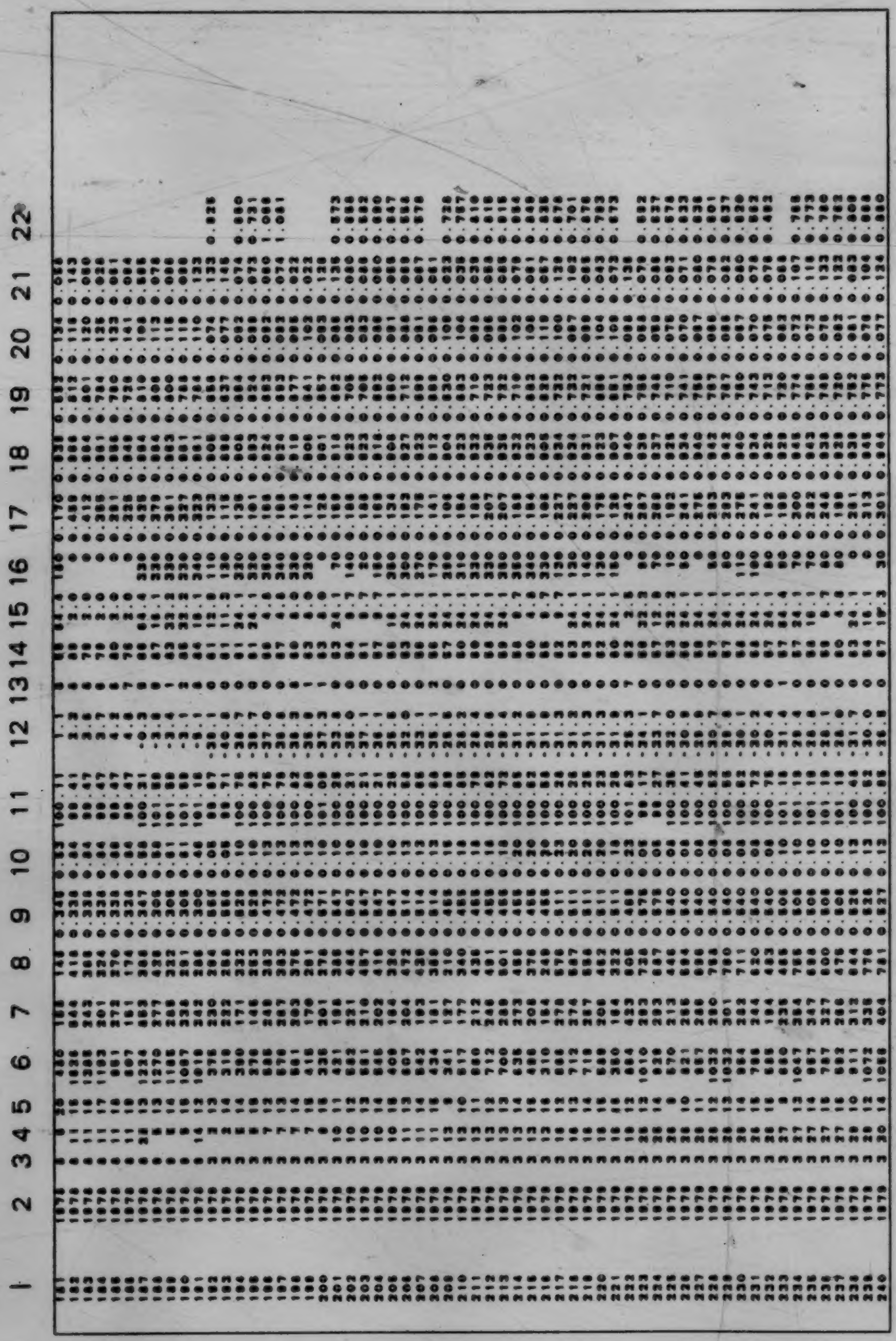

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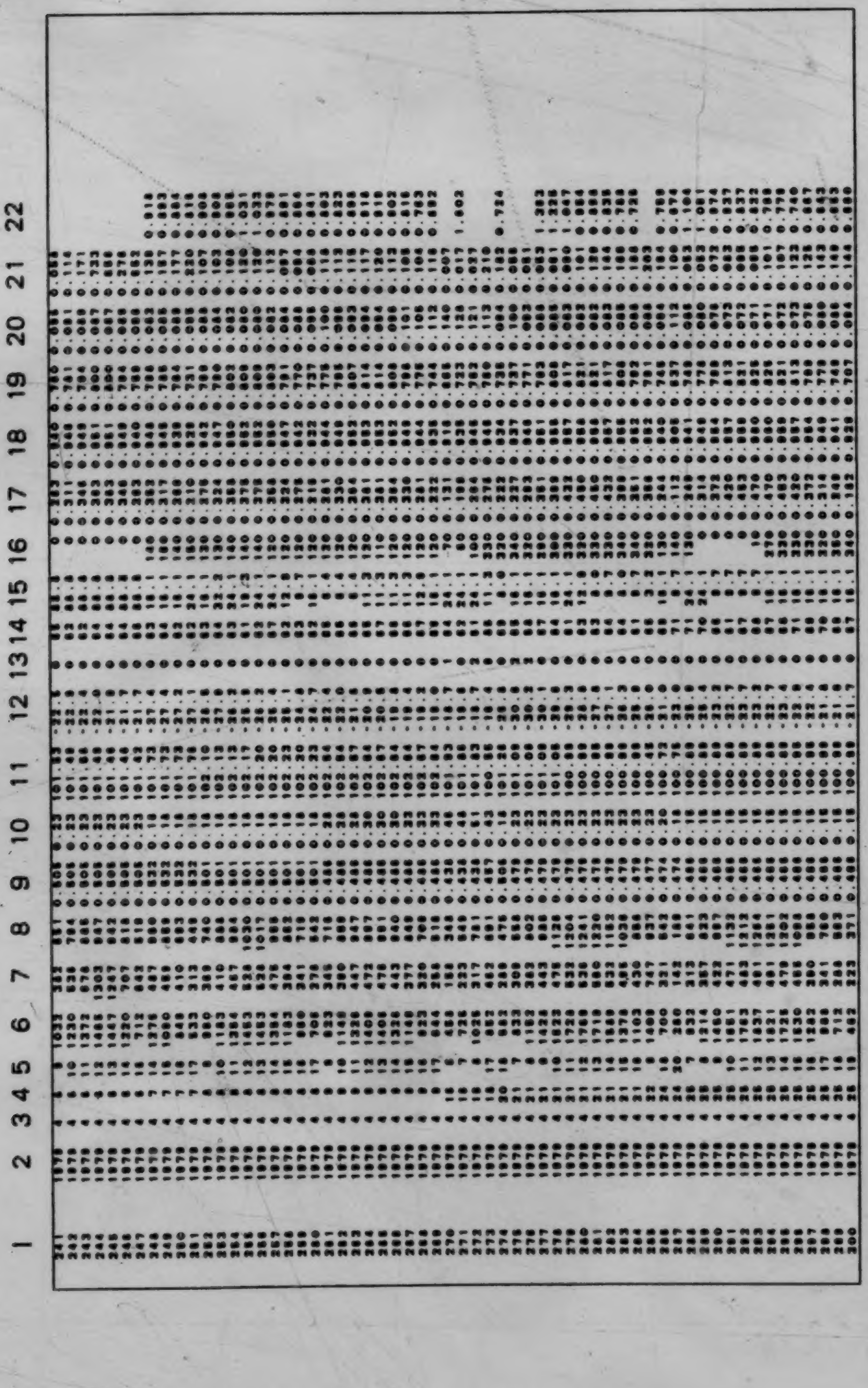

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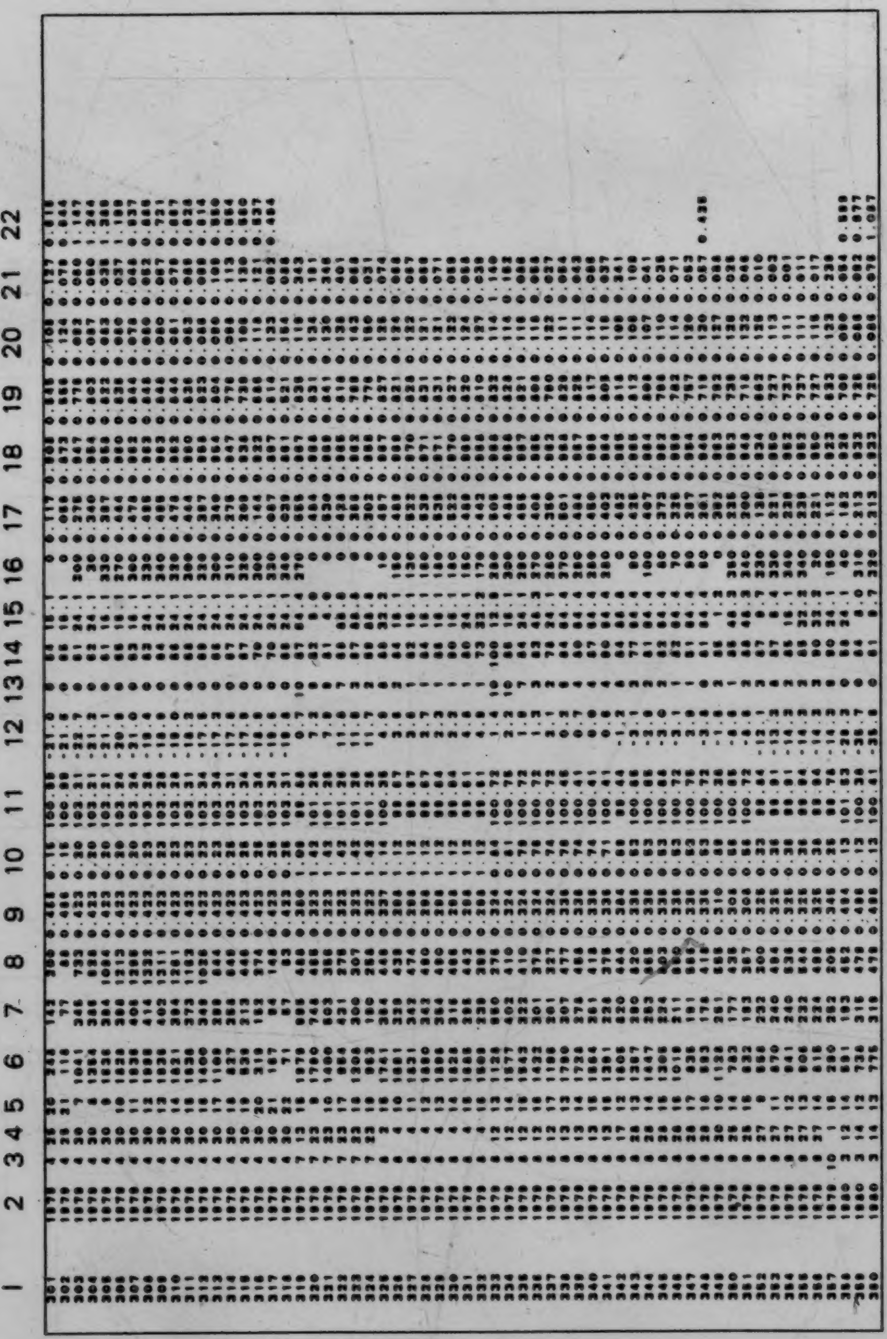

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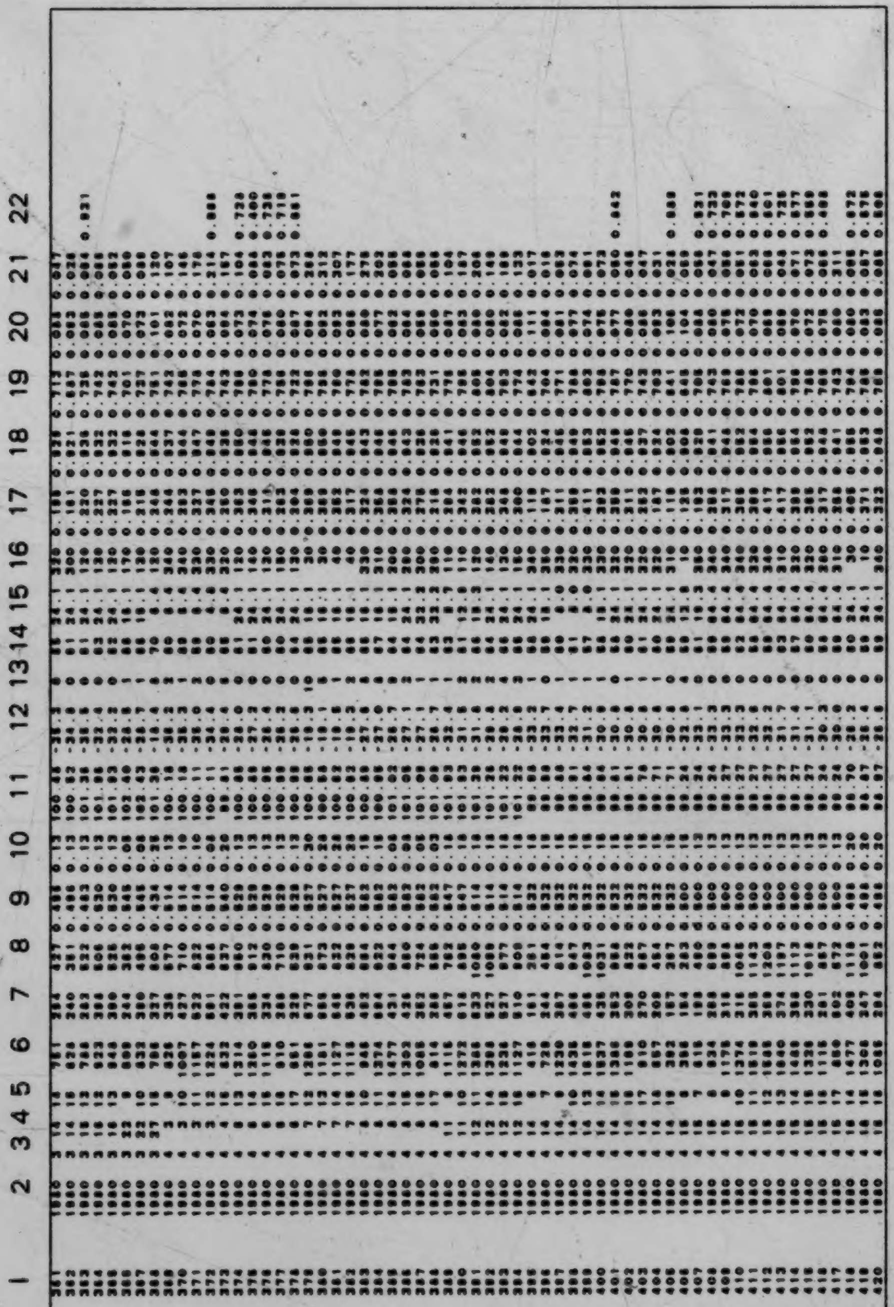

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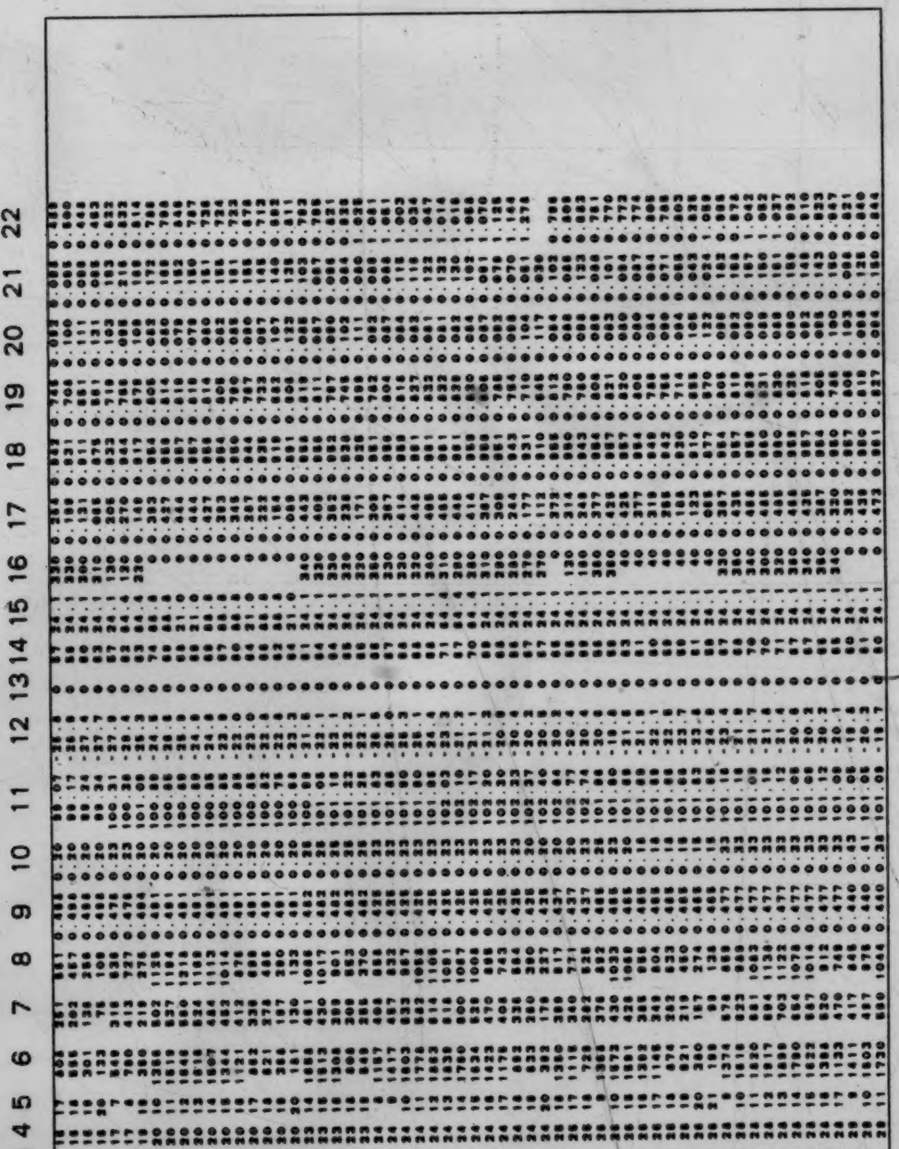

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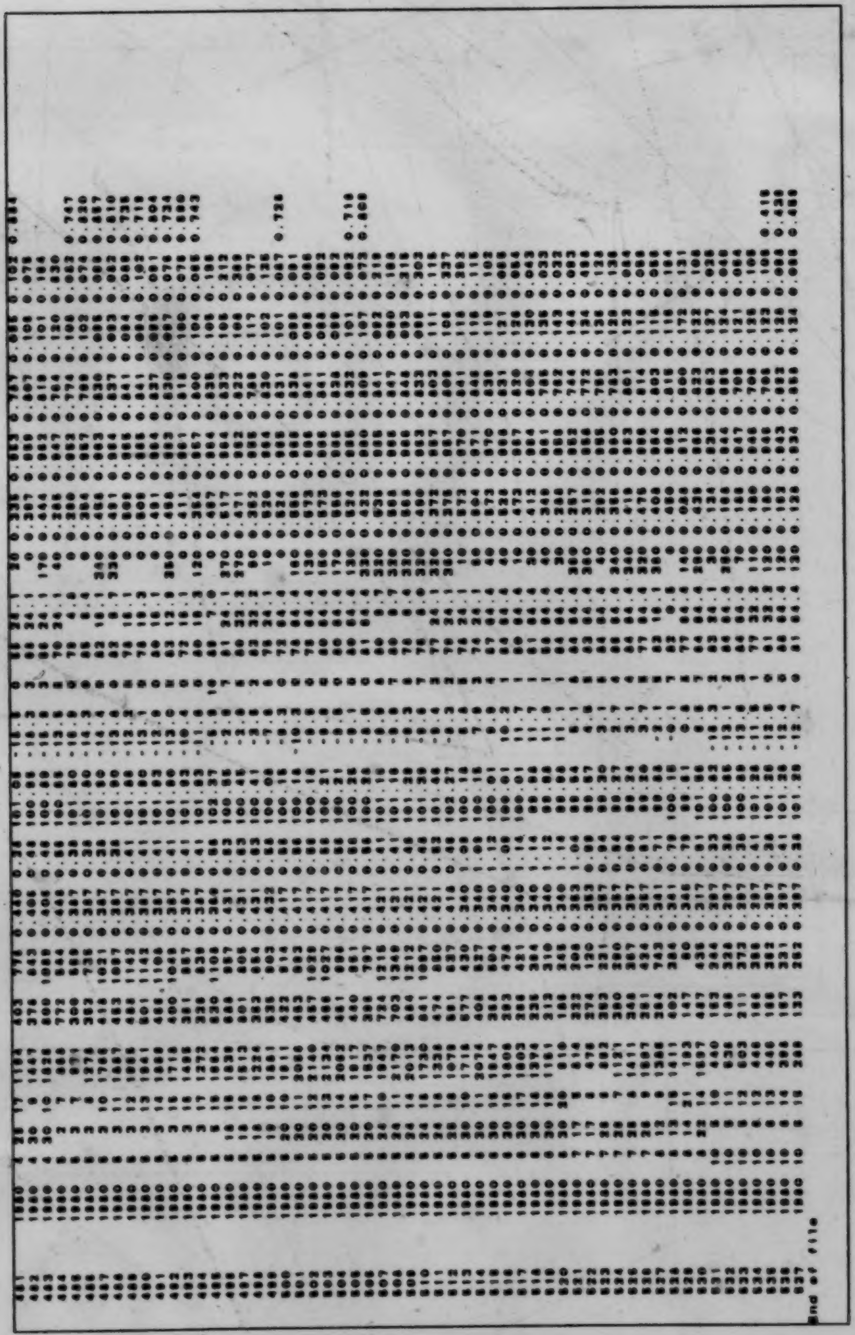

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Appendix B: Data for the other four stations

The columns have the following meaning

1: line number
2: year
3: month
4: day
5: hour
6: global solar radiation (kJ/m^2hour)
7: snowcover (*: snow, 0: no snow)
8: precipitable water (cm liquid)
9: station pressure (kPa)
10: station temperature (°C)
11: cosine of the solar zenith angle
12: ozone transmissivity
13: Rayleigh transmissivity
14: water vapor absorptivity
15: aerosol optical depth

Alert.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1978	3	30	15	446	*	0.23	100.86	-32.7	0.136	0.916	0.666	0.115	0.031
2	1978	4	2	12	663	*	0.10	102.06	-34.2	0.209	0.934	0.732	0.081	0.114
3	1978	4	2	15	676	*	0.10	102.06	-31.2	0.183	0.929	0.713	0.084	0.106
4	1978	4	3	12	703	*	0.10	101.52	-31.0	0.218	0.936	0.733	0.080	0.120
5	1978	4	5	12	663	*	0.18	100.37	-33.0	0.229	0.934	0.734	0.083	0.371
6	1978	4	5	15	653	*	0.18	100.34	-32.0	0.203	0.934	0.718	0.085	0.231
7	1978	4	6	9	702	*	0.18	100.14	-35.5	0.185	0.930	0.704	0.085	-0.006
8	1978	4	6	12	703	*	0.18	100.07	-32.3	0.235	0.940	0.738	0.082	0.207
9	1978	4	6	18	392	*	-0.06	102.02	-25.0	0.136	0.915	0.671	0.074	0.105
10	1978	4	6	21	85	*	0.08	101.82	-28.5	0.040	0.865	0.519	0.086	0.051
11	1978	4	9	6	281	*	0.08	101.85	-30.0	0.108	0.904	0.637	0.089	0.133
12	1978	4	9	9	613	*	0.10	101.92	-30.7	0.205	0.934	0.726	0.081	0.170
13	1978	4	9	12	644	*	0.10	101.36	-28.3	0.254	0.942	0.754	0.078	0.153
14	1978	4	11	9	693	*	0.13	102.09	-35.3	0.217	0.936	0.737	0.085	0.171
15	1978	4	11	12	914	*	0.13	102.18	-34.5	0.287	0.943	0.765	0.081	0.129
16	1978	4	11	15	784	*	0.13	102.26	-32.2	0.241	0.940	0.752	0.083	0.127
17	1978	4	20	12	1150	*	0.25	101.42	-25.7	0.320	0.950	0.784	0.094	0.101
18	1978	4	20	15	1015	*	0.23	101.56	-24.9	0.285	0.947	0.775	0.083	0.126
19	1978	4	20	18	858	*	0.18	101.85	-23.4	0.210	0.938	0.730	0.085	0.120
20	1978	4	20	21	288	*	0.18	101.75	-28.5	0.115	0.907	0.648	0.112	0.111
21	1978	4	20	24	151	*	0.20	101.92	-29.3	0.065	0.878	0.573	0.132	0.022
22	1978	4	21	3	288	*	0.20	102.06	-28.9	0.088	0.894	0.624	0.121	0.038
23	1978	4	21	6	683	*	0.23	102.16	-28.4	0.182	0.929	0.713	0.107	0.071
24	1978	4	21	9	849	*	0.25	102.28	-25.0	0.277	0.945	0.771	0.088	0.109
25	1978	4	21	12	1170	*	0.28	102.33	-22.9	0.326	0.950	0.792	0.085	0.105
26	1978	4	22	3	241	*	0.41	102.19	-22.0	0.104	0.901	0.623	0.144	0.085
27	1978	4	22	9	880	*	0.43	102.08	-22.2	0.283	0.945	0.772	0.114	0.076
28	1978	4	23	12	1201	*	0.48	101.75	-17.5	0.337	0.951	0.793	0.109	0.097
29	1978	4	23	21	382	*	0.43	101.85	-4.2	0.133	0.914	0.687	0.137	0.084
30	1978	4	23	24	211	*	0.43	101.85	-4.5	0.084	0.890	0.603	0.151	0.047
31	1978	4	25	6	823	*	0.48	101.01	-18.5	0.205	0.934	0.723	0.127	0.089
32	1978	4	25	9	1020	*	0.48	100.88	-18.1	0.288	0.948	0.772	0.114	0.102
33	1978	4	25	12	1238	*	0.41	100.81	-3.5	0.348	0.952	0.790	0.103	0.112
34	1978	4	25	21	417	*	0.23	100.94	-6.8	0.144	0.919	0.674	0.112	0.077
35	1978	4	26	12	1341	*	0.15	101.35	-14.5	0.363	0.952	0.786	0.077	0.075
36	1978	5	1	3	362	*	0.28	101.89	-20.5	0.154	0.925	0.687	0.118	0.203
37	1978	5	1	6	758	*	0.23	101.85	-19.0	0.237	0.942	0.746	0.089	0.130
38	1978	5	3	9	1170	*	0.38	101.11	-17.7	0.338	0.953	0.788	0.104	0.130
39	1978	5	3	15	1301	*	0.38	101.11	-16.5	0.359	0.955	0.795	0.102	0.087
40	1978	5	3	18	1447	*	0.38	101.16	-17.8	0.364	0.958	0.796	0.089	-0.028
41	1978	5	6	21	578	*	0.33	100.57	-20.4	0.202	0.937	0.718	0.114	0.151
42	1978	5	7	3	487	*	0.33	100.51	-22.3	0.184	0.933	0.705	0.117	0.161
43	1978	5	7	6	678	*	0.33	100.61	-20.2	0.287	0.947	0.755	0.106	0.114
44	1978	5	7	9	1288	*	0.30	100.57	-18.7	0.359	0.955	0.792	0.085	0.123
45	1978	5	7	12	1517	*	0.30	100.81	-18.1	0.407	0.958	0.807	0.081	0.109
46	1978	5	7	15	1406	*	0.28	100.84	-18.2	0.382	0.957	0.800	0.081	0.110
47	1978	5	7	18	1010	*	0.28	100.68	-18.2	0.299	0.950	0.771	0.097	0.136
48	1978	5	7	21	638	*	0.25	100.74	-18.1	0.207	0.938	0.723	0.105	0.110
49	1978	5	7	24	447	*	0.25	100.81	-18.5	0.159	0.927	0.687	0.113	0.105
50	1978	5	8	3	532	*	0.25	100.98	-18.2	0.169	0.934	0.711	0.106	0.147
51	1978	5	8	6	914	*	0.25	101.08	-19.3	0.271	0.947	0.761	0.088	0.111
52	1978	5	8	9	1318	*	0.28	101.08	-17.0	0.304	0.955	0.787	0.080	0.123
53	1978	5	8	12	1537	*	0.30	100.96	-16.0	0.411	0.958	0.811	0.081	0.110
54	1978	5	8	24	482	*	0.48	100.71	-18.2	0.164	0.928	0.690	0.132	0.082
55	1978	5	9	3	565	*	0.48	100.64	-16.2	0.193	0.935	0.712	0.128	0.118
56	1978	5	9	6	829	*	0.48	100.41	-18.2	0.278	0.944	0.755	0.117	0.065
57	1978	5	11	24	612	*	0.48	100.86	-18.8	0.176	0.932	0.702	0.131	0.085
58	1978	5	12	3	823	*	0.51	100.74	-15.2	0.207	0.938	0.722	0.126	0.100
59	1978	5	12	6	1005	*	0.53	100.81	-15.8	0.289	0.948	0.765	0.118	0.080
60	1978	5	12	9	1406	*	0.58	100.81	-13.6	0.381	0.957	0.798	0.111	0.084

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
61	1978	5	12	12	1836	.	0.55	100.37	-13.1	0.428	0.958	0.811	0.107	0.027
62	1978	5	12	15	1452	.	0.56	100.30	-13.0	0.404	0.958	0.804	0.110	0.116
63	1978	5	15	12	1826	.	0.46	102.43	-6.2	0.440	0.960	0.828	0.103	0.132
64	1978	5	21	6	1246	.	0.38	100.88	-10.3	0.262	0.958	0.793	0.102	0.110
65	1978	5	21	9	1883	.	0.38	100.94	-10.7	0.442	0.960	0.819	0.095	0.085
66	1978	5	21	12	1848	.	0.38	100.94	-6.8	0.486	0.962	0.830	0.092	0.127
67	1978	6	2	12	1884	.	0.46	99.33	-9.2	0.493	0.965	0.819	0.098	0.083
68	1978	6	2	15	1783	.	0.46	99.29	-7.1	0.468	0.964	0.814	0.096	0.085
69	1978	6	2	18	1371	.	0.43	99.23	-8.5	0.369	0.960	0.793	0.101	0.141
70	1978	6	2	21	1018	.	0.41	99.33	-7.4	0.299	0.954	0.782	0.107	0.098
71	1978	6	6	24	635	.	0.46	100.34	-4.6	0.265	0.950	0.753	0.117	0.123
72	1978	6	9	3	919	.	0.48	100.30	-4.5	0.290	0.953	0.784	0.114	0.190
73	1978	6	9	6	1311	.	0.46	100.34	-3.8	0.370	0.958	0.794	0.107	0.106
74	1978	6	9	9	1783	.	0.51	100.30	-1.6	0.459	0.964	0.818	0.102	0.030
75	1978	6	9	15	1844	.	0.50	100.20	0.0	0.461	0.964	0.823	0.103	0.042
76	1978	6	13	21	1070	.	0.61	100.04	-0.3	0.317	0.955	0.774	0.118	0.103
77	1978	6	13	24	674	.	0.63	100.20	-0.4	0.271	0.951	0.765	0.125	0.103
78	1978	6	18	9	1738	0	0.93	100.61	1.3	0.467	0.964	0.832	0.106	-0.011
79	1978	7	3	6	1206	0	1.07	102.83	5.1	0.372	0.961	0.810	0.133	0.091
80	1978	7	23	6	1010	0	1.09	100.07	5.4	0.227	0.956	0.776	0.137	0.090
81	1978	7	23	9	1487	0	1.07	100.04	6.6	0.418	0.964	0.806	0.126	0.026
82	1978	7	26	6	1010	0	0.94	100.30	7.4	0.317	0.958	0.778	0.133	0.088
83	1978	7	26	9	1412	0	0.91	100.34	12.2	0.408	0.963	0.808	0.123	0.041
84	1978	7	27	6	1000	0	0.94	100.24	11.8	0.313	0.957	0.774	0.133	0.063
85	1978	7	27	9	1412	0	0.91	100.14	12.8	0.404	0.963	0.803	0.123	0.029
86	1978	7	27	12	1502	0	0.91	100.04	13.1	0.451	0.965	0.815	0.120	0.031
87	1978	7	27	15	1502	0	0.88	99.93	13.4	0.427	0.964	0.808	0.120	0.031
88	1978	7	27	18	1140	0	0.89	99.90	14.0	0.346	0.960	0.783	0.126	0.058
89	1978	7	27	21	778	0	0.88	99.80	14.0	0.254	0.952	0.745	0.134	0.058
90	1978	7	27	24	582	0	0.91	99.80	13.7	0.207	0.948	0.718	0.147	0.098
91	1978	7	28	3	678	0	0.94	99.90	11.8	0.226	0.949	0.731	0.144	0.083
92	1978	7	28	6	995	0	0.97	100.17	9.3	0.310	0.957	0.772	0.135	0.054
93	1978	7	28	15	1487	0	0.91	100.24	8.0	0.423	0.964	0.809	0.122	0.032
94	1978	7	28	24	833	0	0.98	100.24	3.8	0.203	0.948	0.717	0.151	0.110
95	1978	7	29	3	643	0	1.07	100.24	3.5	0.224	0.948	0.730	0.150	0.088
96	1978	7	29	6	959	0	1.14	100.24	4.6	0.305	0.957	0.771	0.143	0.088
97	1978	7	29	9	1361	0	1.23	100.24	4.9	0.387	0.963	0.803	0.135	0.018
98	1978	8	10	24	382	0	0.88	100.37	4.1	0.165	0.936	0.672	0.161	0.079
99	1978	8	11	3	427	0	0.53	100.44	1.6	0.165	0.941	0.690	0.136	0.087
100	1978	8	11	6	753	0	0.51	100.47	0.1	0.249	0.954	0.748	0.121	0.082
101	1978	8	11	9	1130	0	0.53	100.47	1.0	0.342	0.961	0.790	0.112	0.061
102	1978	8	21	18	583	0	1.07	99.52	1.1	0.220	0.952	0.723	0.148	0.070
103	1978	8	25	15	919	0	0.61	100.34	5.4	0.281	0.956	0.765	0.131	0.073
104	1978	8	28	9	722	0	1.08	100.44	3.0	0.244	0.953	0.743	0.146	0.074
105	1978	8	28	12	829	0	0.97	100.41	1.2	0.284	0.956	0.767	0.137	0.087
106	1978	10	3	12	188	.	0.48	100.61	-10.8	0.085	0.905	0.587	0.103	0.041
107	1979	3	16	12	246	.	0.28	100.77	-11.2	0.094	0.898	0.613	0.126	0.061
108	1979	3	20	12	227	.	0.13	101.84	-30.2	0.121	0.900	0.654	0.101	0.102
109	1979	3	22	15	387	.	0.10	100.70	-34.7	0.109	0.904	0.634	0.097	0.097
110	1979	3	29	12	987	.	0.15	100.43	-30.0	0.182	0.928	0.704	0.094	0.083
111	1979	3	29	15	538	.	0.15	100.88	-30.5	0.157	0.922	0.683	0.098	0.039
112	1979	4	1	15	580	.	0.18	102.29	-36.5	0.177	0.927	0.709	0.101	0.082
113	1979	4	1	18	284	.	0.16	102.18	-32.3	0.090	0.884	0.614	0.120	0.047
114	1979	4	5	12	785	.	0.13	102.60	-27.8	0.220	0.936	0.746	0.085	0.111
115	1979	4	5	15	828	.	0.13	102.63	-24.4	0.203	0.933	0.731	0.087	0.142
116	1979	4	5	18	271	.	0.13	102.56	-26.8	0.117	0.907	0.652	0.103	0.156
117	1979	4	6	9	525	.	0.10	102.43	-29.3	0.185	0.929	0.717	0.084	0.058
118	1979	4	6	12	610	.	0.12	102.20	-30.2	0.228	0.939	0.740	0.084	0.094
119	1979	4	7	6	203	.	0.16	102.09	-30.7	0.086	0.887	0.623	0.118	0.141
120	1979	4	8	15	847	.	0.15	102.88	-28.0	0.222	0.937	0.743	0.090	0.228

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
121	1979	4	8	21	89	*	0.15	102.90	-28.8	0.046	0.958	0.622	0.136	0.059
122	1979	4	9	9	564	*	0.15	103.03	-20.8	0.208	0.933	0.734	0.097	0.185
123	1979	4	11	9	926	*	0.26	103.44	-21.5	0.217	0.935	0.745	0.109	0.181
124	1979	4	11	12	958	*	0.38	103.44	-21.4	0.287	0.943	0.773	0.110	0.184
125	1979	4	15	3	106	*	0.15	103.27	-29.8	0.061	0.973	0.589	0.131	0.129
126	1979	4	15	9	899	*	0.16	103.37	-20.0	0.242	0.930	0.759	0.083	0.026
127	1979	4	15	12	1061	*	0.18	103.36	-27.4	0.291	0.948	0.764	0.088	0.080
128	1979	4	15	15	820	*	0.16	103.27	-28.6	0.268	0.943	0.771	0.090	0.221
129	1979	4	15	18	494	*	0.18	103.27	-28.5	0.180	0.926	0.717	0.101	0.175
130	1979	4	15	21	251	*	0,20	103.27	-30.0	0.085	0.890	0.611	0.128	0.026
131	1979	4	16	15	872	*	0.16	102.90	-26.0	0.271	0.944	0.772	0.089	0.189
132	1979	4	16	18	542	*	0.18	102.90	-29.0	0.168	0.929	0.730	0.098	0.144
133	1979	4	16	21	227	*	0.18	102.78	-28.8	0.091	0.894	0.618	0.114	0.078
134	1979	4	16	24	100	*	0.15	102.68	-30.3	0.042	0.867	0.526	0.134	0.040
135	1979	4	17	3	189	*	0.15	102.58	-31.0	0.074	0.863	0.588	0.130	0.052
136	1979	4	17	6	484	*	0.15	102.33	-29.9	0.159	0.922	0.694	0.098	0.082
137	1979	4	17	9	803	*	0.15	102.28	-28.7	0.264	0.942	0.759	0.087	0.185
138	1979	4	17	15	888	*	0.18	101.99	-29.4	0.277	0.945	0.768	0.086	0.207
139	1979	4	24	12	1229	*	0.28	101.01	-25.1	0.342	0.952	0.790	0.082	0.121
140	1979	4	24	15	1064	*	0.25	101.01	-25.0	0.317	0.949	0.780	0.084	0.181
141	1979	4	24	18	711	*	0.25	101.01	-24.9	0.233	0.939	0.740	0.102	0.157
142	1979	4	24	21	347	*	0.26	101.06	-26.8	0.139	0.917	0.689	0.118	0.135
143	1979	4	25	3	316	*	0.25	101.15	-26.0	0.121	0.910	0.650	0.122	0.089
144	1979	4	25	6	717	*	0.28	101.18	-25.5	0.206	0.934	0.724	0.106	0.031
145	1979	4	25	9	1112	*	0.23	101.21	-27.0	0.299	0.948	0.774	0.093	0.044
146	1979	4	25	12	1256	*	0.20	101.21	-25.7	0.348	0.952	0.783	0.085	0.130
147	1979	4	25	15	1129	*	0.20	101.18	-25.3	0.323	0.950	0.784	0.087	0.148
148	1979	4	25	18	752	*	0.16	101.16	-25.1	0.238	0.940	0.744	0.092	0.181
149	1979	4	25	21	371	*	0.18	101.18	-22.7	0.144	0.918	0.675	0.108	0.140
150	1979	4	26	18	776	*	0.20	101.32	-22.8	0.244	0.941	0.748	0.095	0.145
151	1979	4	26	21	408	*	0.20	101.28	-21.7	0.150	0.920	0.681	0.108	0.117
152	1979	4	26	24	233	*	0.20	101.18	-23.9	0.101	0.901	0.626	0.120	0.110
153	1979	4	27	24	233	*	0.20	100.44	-24.3	0.107	0.904	0.629	0.118	0.141
154	1979	4	28	15	1191	*	0.20	101.72	-19.3	0.330	0.951	0.783	0.085	0.158
155	1979	4	28	18	803	*	0.20	101.98	-18.1	0.285	0.942	0.758	0.094	0.170
156	1979	4	28	21	405	*	0.23	102.26	-18.8	0.161	0.923	0.686	0.110	0.179
157	1979	5	1	15	1253	*	0.33	102.92	-18.4	0.354	0.954	0.808	0.088	0.144
158	1979	5	3	24	422	*	0.23	103.44	-21.4	0.139	0.920	0.681	0.115	0.055
159	1979	5	4	3	558	*	0.20	103.30	-18.4	0.189	0.928	0.708	0.106	0.047
160	1979	5	4	6	886	*	0.20	103.00	-18.4	0.252	0.944	0.753	0.094	0.080
161	1979	5	4	9	1284	*	0.20	102.76	-19.2	0.348	0.954	0.802	0.088	0.089
162	1979	5	4	12	1462	*	0.20	102.58	-19.8	0.383	0.957	0.817	0.083	0.140
163	1979	5	4	15	1328	*	0.20	102.36	-18.0	0.368	0.956	0.808	0.084	0.187
164	1979	5	5	21	666	*	0.28	102.60	-13.6	0.197	0.935	0.726	0.106	0.152
165	1979	5	5	24	391	*	0.25	102.60	-13.3	0.140	0.923	0.686	0.118	0.131
166	1979	5	6	3	474	*	0.26	102.72	-14.1	0.179	0.931	0.714	0.110	0.177
167	1979	5	6	6	864	*	0.25	102.70	-11.8	0.282	0.945	0.768	0.098	0.149
168	1979	5	6	9	1273	*	0.28	102.82	-9.7	0.355	0.954	0.805	0.093	0.131
169	1979	5	9	18	889	*	0.43	102.16	-8.9	0.306	0.951	0.784	0.110	0.199
170	1979	5	13	24	590	*	0.48	100.88	-15.7	0.166	0.934	0.709	0.130	0.061
171	1979	5	15	3	842	*	0.46	101.42	-13.7	0.219	0.940	0.735	0.124	0.162
172	1979	5	15	9	1478	*	0.41	101.62	-14.4	0.383	0.957	0.810	0.101	0.097
173	1979	5	15	12	1600	*	0.41	101.65	-14.0	0.440	0.960	0.823	0.096	0.081
174	1979	5	16	6	1009	*	0.33	101.52	-4.9	0.306	0.951	0.779	0.102	0.182
175	1979	5	16	15	1585	*	0.33	101.45	-2.7	0.419	0.960	0.817	0.092	0.124
176	1979	5	16	18	1187	*	0.33	101.45	-3.6	0.337	0.953	0.781	0.099	0.148
177	1979	5	16	21	778	*	0.38	101.42	-4.7	0.246	0.944	0.750	0.110	0.127
178	1979	5	16	24	504	*	0.38	101.42	-4.7	0.188	0.936	0.721	0.118	0.117
179	1979	5	17	3	687	*	0.38	101.42	-4.7	0.227	0.941	0.739	0.118	0.123
180	1979	5	17	9	1488	*	0.43	101.35	-3.5	0.400	0.958	0.810	0.101	0.082

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Alert

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
181	1979	5	17	15	1082	*	0.43	101.13	-3.4	0.423	0.965	0.815	0.106	0.112
182	1979	5	17	18	1181	*	0.43	101.08	-3.4	0.341	0.964	0.790	0.106	0.128
183	1979	5	17	21	807	*	0.43	100.88	-3.7	0.250	0.944	0.748	0.115	0.101
184	1979	5	17	24	611	*	0.41	100.61	-4.5	0.203	0.937	0.719	0.120	0.102
185	1979	5	18	3	697	*	0.38	100.46	-5.2	0.231	0.942	0.736	0.114	0.139
186	1979	5	18	6	1030	*	0.38	100.20	-5.0	0.313	0.952	0.772	0.102	0.185
187	1979	5	18	9	1468	*	0.38	100.07	-2.7	0.404	0.958	0.803	0.086	0.128
188	1979	5	18	12	1868	*	0.38	99.87	-1.4	0.451	0.961	0.814	0.082	0.184
189	1979	5	18	15	1848	*	0.38	99.73	0.0	0.427	0.960	0.807	0.083	0.150
190	1979	5	18	18	1170	*	0.38	99.70	-1.4	0.348	0.954	0.782	0.088	0.168
191	1979	5	18	24	614	*	0.41	100.41	-5.7	0.211	0.936	0.723	0.119	0.134
192	1979	5	20	3	707	*	0.41	100.24	-4.5	0.238	0.943	0.736	0.118	0.164
193	1979	5	24	15	1886	*	0.23	101.08	-12.5	0.448	0.950	0.821	0.061	0.185
194	1979	5	24	18	1287	*	0.23	101.05	-12.3	0.385	0.955	0.788	0.088	0.149
195	1979	6	17	15	1863	*	0.51	100.32	-2.3	0.486	0.965	0.828	0.105	0.049
196	1979	7	10	9	1616	0	1.02	100.23	4.0	0.451	0.965	0.816	0.124	0.007
197	1979	7	10	12	1813	0	0.89	100.26	3.0	0.487	0.967	0.827	0.120	0.001
198	1979	7	18	3	866	0	0.94	100.77	5.3	0.270	0.953	0.754	0.139	0.041
199	1979	7	20	15	1418	0	1.18	101.27	2.1	0.418	0.963	0.814	0.133	0.084
200	1979	7	21	3	808	0	1.27	101.07	2.3	0.218	0.947	0.730	0.158	0.088
201	1979	7	21	9	1312	0	1.40	101.07	2.4	0.389	0.952	0.805	0.141	0.043
202	1979	8	15	15	1231	0	0.65	100.13	-0.4	0.348	0.962	0.785	0.118	0.007
203	1979	8	15	21	471	0	0.63	100.23	-1.2	0.168	0.942	0.691	0.142	0.054
204	1979	8	18	3	375	0	0.66	100.28	-3.3	0.139	0.938	0.665	0.150	0.048
205	1979	8	21	9	972	0	0.58	99.82	1.5	0.280	0.956	0.762	0.120	0.038
206	1979	8	21	12	1165	0	0.58	99.88	2.3	0.339	0.961	0.781	0.118	0.042
207	1979	8	21	15	1088	0	0.58	99.98	2.7	0.314	0.960	0.772	0.117	0.044
208	1979	8	21	24	187	0	0.61	100.19	0.5	0.068	0.915	0.590	0.163	0.056
209	1980	3	13	15	159	*	0.16	99.82	-32.1	0.048	0.864	0.527	0.135	0.002
210	1980	3	26	9	339	*	0.16	102.45	-31.8	0.112	0.906	0.640	0.114	0.048
211	1980	3	26	12	396	*	0.16	102.45	-32.0	0.162	0.923	0.686	0.103	0.227
212	1980	3	26	15	324	*	0.16	102.45	-31.0	0.136	0.914	0.673	0.106	0.163
213	1980	3	27	12	456	*	0.15	102.21	-34.2	0.188	0.926	0.703	0.098	0.175
214	1980	3	27	15	359	*	0.15	102.19	-36.5	0.143	0.917	0.679	0.102	0.189
215	1980	4	1	15	453	*	0.15	101.27	-33.4	0.177	0.926	0.704	0.095	0.230
216	1980	4	2	9	309	*	0.15	101.27	-35.3	0.158	0.923	0.688	0.098	0.766
217	1980	4	3	6	604	*	0.13	100.87	-35.5	0.166	0.925	0.693	0.093	0.100
218	1980	4	3	12	514	*	0.13	100.77	-32.1	0.216	0.936	0.726	0.085	0.612
219	1980	4	3	15	421	*	0.13	100.83	-35.6	0.180	0.931	0.710	0.088	0.536
220	1980	4	3	18	284	*	0.13	100.80	-33.1	0.104	0.902	0.628	0.104	0.093
221	1980	4	4	6	162	*	0.13	100.50	-35.5	0.076	0.886	0.585	0.112	0.106
222	1980	4	4	9	822	*	0.13	100.50	-34.7	0.172	0.927	0.698	0.081	0.016
223	1980	4	4	12	613	*	0.13	100.46	-33.2	0.222	0.937	0.731	0.085	0.036
224	1980	4	4	15	576	*	0.15	100.50	-33.6	0.186	0.932	0.714	0.093	0.156
225	1980	4	4	18	288	*	0.15	100.60	-35.2	0.110	0.906	0.634	0.108	0.088
226	1980	4	5	9	656	*	0.23	100.50	-32.0	0.178	0.928	0.701	0.107	0.063
227	1980	4	5	12	666	*	0.23	100.43	-32.9	0.229	0.936	0.724	0.100	0.209
228	1980	4	7	18	382	*	0.25	101.14	-27.0	0.130	0.913	0.660	0.120	0.058
229	1980	4	18	3	171	*	0.25	98.81	-22.2	0.067	0.861	0.582	0.137	0.040
230	1980	4	23	15	1106	*	0.18	100.83	-23.6	0.312	0.949	0.776	0.084	0.120
231	1980	4	23	18	783	*	0.18	100.83	-24.5	0.227	0.936	0.738	0.093	0.068
232	1980	4	24	3	352	*	0.20	100.87	-27.0	0.118	0.907	0.642	0.118	0.036
233	1980	4	24	6	683	*	0.20	101.03	-25.0	0.200	0.933	0.718	0.100	0.063
234	1980	4	24	9	1055	*	0.23	101.17	-23.6	0.294	0.947	0.772	0.093	0.078
235	1980	4	24	12	1268	*	0.23	101.27	-24.0	0.342	0.952	0.781	0.088	0.089
236	1980	4	24	15	1128	*	0.23	101.44	-22.9	0.317	0.948	0.783	0.081	0.114
237	1980	4	25	15	1228	*	0.23	102.58	-24.4	0.323	0.949	0.793	0.081	0.040
238	1980	4	25	21	392	*	0.23	102.62	-24.4	0.144	0.918	0.682	0.114	0.106
239	1980	4	25	24	231	*	0.23	102.62	-26.2	0.088	0.887	0.624	0.126	0.084
240	1980	4	26	3	332	*	0.20	102.55	-28.5	0.126	0.911	0.683	0.114	0.100

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Alert

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
241	1980	4	25	6	733	*	0.20	102.52	-25.5	0.211	0.834	0.735	0.100	0.084
242	1980	4	26	9	1075	*	0.20	102.45	-24.6	0.305	0.948	0.764	0.089	0.118
243	1980	4	26	12	1288	*	0.20	102.35	-24.1	0.383	0.952	0.802	0.085	0.117
244	1980	4	26	15	1168	*	0.20	102.21	-24.1	0.328	0.950	0.782	0.087	0.111
245	1980	4	26	18	784	*	0.20	102.11	-23.1	0.244	0.940	0.753	0.095	0.138
246	1980	4	26	24	281	*	0.20	101.84	-25.7	0.101	0.900	0.629	0.120	0.074
247	1980	4	27	3	372	*	0.20	101.71	-26.1	0.132	0.914	0.665	0.112	0.078
248	1980	4	27	6	853	*	0.20	101.61	-25.5	0.218	0.938	0.734	0.096	0.148
249	1980	4	29	15	1278	*	0.20	100.73	-18.2	0.344	0.952	0.788	0.085	0.080
250	1980	4	29	18	894	*	0.20	100.80	-24.3	0.260	0.943	0.753	0.093	0.088
251	1980	4	29	21	522	*	0.23	100.97	-24.6	0.165	0.925	0.694	0.109	0.052
252	1980	4	29	24	242	*	0.23	101.07	-25.4	0.118	0.906	0.648	0.119	0.061
253	1980	5	2	12	1462	*	0.30	100.63	-21.6	0.384	0.957	0.802	0.083	0.056
254	1980	5	2	15	1325	*	0.30	100.93	-20.5	0.359	0.955	0.795	0.085	0.080
255	1980	5	2	24	357	*	0.33	101.24	-19.7	0.134	0.919	0.685	0.128	0.092
256	1980	5	3	3	482	*	0.33	101.37	-18.6	0.184	0.926	0.694	0.121	0.105
257	1980	5	4	18	844	*	0.33	102.55	-17.5	0.285	0.944	0.778	0.108	0.143
258	1980	5	5	3	612	*	0.30	102.65	-19.3	0.174	0.930	0.710	0.118	0.094
259	1980	5	5	6	869	*	0.30	102.95	-19.0	0.257	0.945	0.765	0.106	0.092
260	1980	5	5	9	1261	*	0.30	103.05	-17.2	0.350	0.954	0.808	0.087	0.116
261	1980	5	5	12	1492	*	0.30	103.12	-18.6	0.388	0.957	0.822	0.083	0.106
262	1980	5	5	15	1356	*	0.30	103.19	-15.4	0.373	0.956	0.815	0.086	0.133
263	1980	5	5	24	392	*	0.33	103.32	-15.6	0.149	0.923	0.691	0.125	0.123
264	1980	5	6	18	1015	*	0.43	103.09	-5.1	0.295	0.949	0.764	0.112	0.095
265	1980	5	6	21	523	*	0.48	102.99	-7.5	0.202	0.936	0.732	0.128	0.089
266	1980	5	7	3	578	*	0.48	102.79	-13.2	0.184	0.932	0.718	0.131	0.086
267	1980	5	8	6	1025	*	0.56	102.52	-14.7	0.278	0.947	0.773	0.124	-0.005
268	1980	5	8	7	1180	*	0.56	102.52	-15.0	0.308	0.950	0.787	0.120	-0.021
269	1980	5	9	6	1311	*	0.56	102.62	-14.5	0.340	0.953	0.799	0.117	-0.019
270	1980	5	9	9	1401	*	0.58	102.58	-13.6	0.385	0.955	0.809	0.113	0.013
271	1980	5	9	12	1617	*	0.53	102.55	-13.2	0.418	0.958	0.823	0.108	0.008
272	1980	5	9	18	1100	*	0.48	102.41	-15.7	0.304	0.951	0.786	0.114	0.082
273	1980	5	12	15	1482	*	0.53	101.03	-10.6	0.404	0.958	0.809	0.106	0.092
274	1980	5	13	9	1005	*	0.30	100.77	-12.3	0.292	0.950	0.769	0.100	0.105
275	1980	5	13	18	1175	*	0.28	100.68	-14.1	0.328	0.953	0.781	0.088	0.080
276	1980	5	18	24	563	*	0.53	101.74	-14.0	0.198	0.936	0.723	0.131	0.107
277	1980	5	28	12	1833	*	0.48	102.88	-9.2	0.478	0.962	0.839	0.089	0.071
278	1980	5	28	15	1706	*	0.48	102.78	-8.2	0.452	0.960	0.834	0.101	0.085
279	1980	5	28	21	908	*	0.43	102.78	-9.7	0.281	0.948	0.776	0.113	0.137
280	1980	5	28	24	713	*	0.43	102.75	-10.6	0.234	0.941	0.751	0.119	0.135
281	1980	6	1	9	1703	*	0.43	99.99	-8.1	0.444	0.963	0.812	0.096	0.040
282	1980	6	3	18	1422	*	0.51	100.23	-7.0	0.391	0.960	0.800	0.112	0.070
283	1980	6	4	12	1884	*	0.56	100.56	-5.2	0.487	0.965	0.838	0.103	0.079
284	1980	6	5	18	1415	*	0.48	101.24	-5.5	0.395	0.960	0.808	0.105	0.120
285	1980	6	5	21	990	*	0.48	101.27	-5.2	0.305	0.954	0.777	0.111	0.184
286	1980	6	5	24	778	*	0.48	101.27	-7.0	0.259	0.948	0.755	0.117	0.178
287	1980	6	6	3	914	*	0.43	101.24	-5.5	0.285	0.952	0.755	0.112	0.151
288	1980	6	6	6	1271	*	0.43	101.20	-5.5	0.385	0.956	0.799	0.104	0.141
289	1980	6	6	9	1743	*	0.43	101.17	-5.6	0.454	0.963	0.823	0.095	0.052
290	1980	6	6	12	1959	*	0.43	101.03	-6.1	0.500	0.965	0.833	0.095	0.037
291	1980	6	6	21	1065	*	0.43	100.59	-2.0	0.307	0.954	0.773	0.108	0.085
292	1980	6	7	21	1000	*	0.38	99.98	-6.0	0.309	0.954	0.770	0.103	0.176
293	1980	6	7	24	1065	*	0.41	99.88	-6.0	0.282	0.950	0.749	0.112	-0.074
294	1980	6	21	18	1484	*	0.66	101.07	0.2	0.410	0.961	0.811	0.113	0.079
295	1980	6	22	21	1009	*	0.78	101.27	1.5	0.322	0.956	0.784	0.126	0.189
296	1980	6	22	24	623	*	0.81	101.27	0.2	0.276	0.951	0.764	0.134	0.176
297	1980	7	4	9	1248	0	1.04	100.87	3.0	0.371	0.961	0.798	0.132	0.045
298	1980	7	4	15	1719	0	1.07	100.83	3.5	0.482	0.966	0.828	0.124	0.029
299	1980	7	13	6	995	0	1.14	101.10	4.5	0.355	0.960	0.795	0.137	0.275
300	1980	7	13	9	1533	0	1.17	101.14	4.4	0.444	0.965	0.821	0.130	0.082

301	1980	7	25	9	1426	0	0.97	100.02	2.5	0.408	0.963	0.803	0.125	0.026
302	1980	9	18	15	470	*	0.30	100.50	-20.2	0.141	0.936	0.668	0.122	0.025
303	1980	9	21	15	286	*	0.28	100.50	-14.9	0.121	0.932	0.647	0.124	0.122

End of file

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Inuvik

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1978	2	12	10	157	*	0.38	100.47	-15.3	0.061	0.875	0.553	0.158	0.032
2	1978	2	14	10	192	*	0.48	100.04	-13.6	0.072	0.883	0.575	0.158	0.022
3	1978	2	14	11	327	*	0.43	100.04	-13.7	0.119	0.909	0.642	0.140	0.058
4	1978	2	14	12	425	*	0.43	100.07	-17.4	0.143	0.919	0.688	0.134	0.055
5	1978	2	14	13	468	*	0.43	100.07	-17.8	0.143	0.919	0.688	0.134	0.048
6	1978	2	14	14	303	*	0.43	100.07	-15.0	0.119	0.909	0.642	0.140	0.055
7	1978	2	18	13	698	*	0.41	88.84	-28.1	0.167	0.926	0.689	0.127	-0.080
8	1978	2	23	11	628	*	0.41	100.48	-18.8	0.173	0.927	0.699	0.128	0.001
9	1978	2	23	12	788	*	0.41	100.81	-17.3	0.198	0.933	0.717	0.122	-0.036
10	1978	2	23	13	761	*	0.41	100.78	-18.3	0.198	0.933	0.717	0.122	-0.013
11	1978	2	23	14	570	*	0.41	100.78	-18.4	0.173	0.927	0.698	0.128	0.046
12	1978	2	23	16	381	*	0.43	100.78	-12.9	0.126	0.912	0.653	0.138	0.058
13	1978	2	24	11	589	*	0.53	100.61	-11.8	0.179	0.929	0.702	0.134	0.071
14	1978	2	24	12	863	*	0.53	100.57	-8.8	0.204	0.934	0.720	0.129	0.070
15	1978	2	24	13	583	*	0.53	100.57	-8.3	0.204	0.934	0.720	0.129	0.147
16	1978	3	1	9	303	*	0.33	103.23	-18.1	0.086	0.896	0.627	0.139	0.015
17	1978	3	1	10	536	*	0.30	103.23	-18.4	0.183	0.923	0.703	0.120	0.048
18	1978	3	1	11	727	*	0.30	103.17	-18.7	0.211	0.934	0.739	0.112	0.060
19	1978	3	1	12	838	*	0.28	103.20	-18.8	0.228	0.938	0.755	0.108	0.082
20	1978	3	1	13	820	*	0.28	103.17	-18.0	0.230	0.938	0.755	0.108	0.078
21	1978	3	1	14	721	*	0.25	103.10	-17.4	0.211	0.934	0.739	0.108	0.071
22	1978	3	1	15	528	*	0.28	103.07	-18.8	0.183	0.923	0.702	0.114	0.058
23	1978	3	1	16	279	*	0.28	103.03	-15.4	0.098	0.895	0.628	0.128	0.039
24	1978	3	2	9	291	*	0.30	102.29	-23.1	0.102	0.900	0.631	0.124	0.047
25	1978	3	2	10	535	*	0.30	102.28	-25.8	0.170	0.925	0.703	0.118	0.072
26	1978	3	2	11	738	*	0.30	102.23	-25.8	0.217	0.935	0.738	0.111	0.074
27	1978	3	2	12	832	*	0.30	102.19	-19.8	0.242	0.940	0.753	0.107	0.088
28	1978	3	2	13	838	*	0.30	102.09	-18.7	0.242	0.940	0.752	0.107	0.083
29	1978	3	2	14	727	*	0.30	102.08	-17.5	0.217	0.935	0.737	0.110	0.085
30	1978	3	2	15	529	*	0.30	102.06	-15.8	0.170	0.925	0.702	0.118	0.077
31	1978	3	2	16	279	*	0.30	102.02	-15.7	0.102	0.900	0.630	0.123	0.057
32	1978	4	2	12	1871	*	0.20	101.55	-26.1	0.440	0.958	0.823	0.080	0.350
33	1978	4	2	13	1842	*	0.20	101.55	-24.8	0.440	0.958	0.823	0.080	0.422
34	1978	4	2	14	1427	*	0.20	101.55	-23.7	0.415	0.957	0.815	0.081	0.410
35	1978	4	2	15	1228	*	0.20	101.55	-23.3	0.387	0.954	0.802	0.084	0.325
36	1978	4	2	16	982	*	0.20	101.55	-22.7	0.288	0.947	0.778	0.089	0.214
37	1978	4	2	17	862	*	0.20	101.58	-22.2	0.216	0.928	0.733	0.098	0.124
38	1978	4	3	9	1092	*	0.23	101.85	-28.8	0.305	0.948	0.779	0.092	0.108
39	1978	4	4	11	1577	*	0.20	101.32	-28.8	0.427	0.958	0.818	0.080	0.226
40	1978	4	4	12	1704	*	0.20	101.32	-25.3	0.452	0.959	0.824	0.078	0.223
41	1978	4	4	13	1688	*	0.20	101.32	-22.6	0.452	0.959	0.824	0.078	0.233
42	1978	4	4	14	1589	*	0.20	101.33	-20.8	0.427	0.958	0.818	0.080	0.206
43	1978	4	4	15	1352	*	0.20	101.33	-19.8	0.378	0.954	0.804	0.083	0.218
44	1978	4	5	8	716	*	0.20	101.42	-27.8	0.234	0.939	0.743	0.098	0.183
45	1978	4	5	11	1694	*	0.20	101.42	-20.8	0.433	0.958	0.820	0.080	0.252
46	1978	4	5	12	1710	*	0.20	101.38	-17.2	0.458	0.959	0.828	0.078	0.258
47	1978	4	5	13	1718	*	0.20	101.35	-16.1	0.458	0.959	0.826	0.078	0.247
48	1978	4	5	14	1606	*	0.20	101.35	-14.9	0.433	0.958	0.820	0.079	0.231
49	1978	4	5	15	1302	*	0.20	101.32	-14.4	0.385	0.955	0.806	0.082	0.205
50	1978	4	5	16	1074	*	0.18	101.28	-14.4	0.317	0.948	0.782	0.084	0.211
51	1978	4	5	17	734	*	0.18	101.25	-14.0	0.234	0.939	0.742	0.092	0.162
52	1978	4	8	14	1631	*	0.30	100.98	-22.7	0.451	0.959	0.821	0.089	0.513
53	1978	4	8	15	1277	*	0.33	101.01	-22.1	0.403	0.956	0.808	0.094	0.509
54	1978	4	10	7	474	*	0.61	100.90	-15.8	0.172	0.927	0.683	0.140	0.110
55	1978	4	14	7	595	*	0.48	102.39	-7.4	0.198	0.931	0.724	0.128	0.089
56	1978	4	14	8	978	*	0.48	102.29	-8.8	0.287	0.948	0.776	0.118	0.104
57	1978	4	14	10	1675	*	0.48	102.18	-6.1	0.437	0.958	0.825	0.103	0.079
58	1978	4	19	6	352	*	0.61	102.19	-10.1	0.128	0.912	0.663	0.151	0.080
59	1978	4	19	7	859	*	0.61	102.12	-8.8	0.223	0.937	0.741	0.132	0.136
60	1978	4	19	8	1040	*	0.63	102.08	-9.0	0.315	0.949	0.788	0.122	0.151

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Inuvik

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
61	1978	4	19	9	1410	*	0.83	102.08	-5.1	0.397	0.959	0.814	0.114	0.153
62	1978	4	19	10	1696	*	0.83	101.99	-4.8	0.464	0.959	0.832	0.109	0.189
63	1978	4	19	14	1941	*	0.89	101.82	-0.9	0.511	0.962	0.841	0.106	0.148
64	1978	4	19	15	1881	*	0.71	101.82	-0.7	0.464	0.959	0.830	0.112	0.202
65	1978	4	21	9	1473	*	0.25	101.88	-14.7	0.407	0.956	0.818	0.087	0.204
66	1978	4	21	10	1779	*	0.26	101.85	-13.8	0.474	0.960	0.832	0.083	0.222
67	1978	4	21	11	2032	*	0.25	101.82	-11.8	0.521	0.962	0.842	0.080	0.200
68	1978	4	21	12	2160	*	0.25	101.85	-11.3	0.546	0.963	0.846	0.078	0.188
69	1978	4	21	13	2186	*	0.25	101.85	-10.4	0.548	0.963	0.848	0.078	0.177
70	1978	4	21	14	2010	*	0.25	101.53	-8.5	0.521	0.962	0.841	0.080	0.220
71	1978	4	21	15	1768	*	0.26	101.46	-8.3	0.474	0.960	0.830	0.085	0.228
72	1978	4	21	16	1479	*	0.26	101.46	-8.4	0.407	0.956	0.813	0.088	0.188
73	1978	4	21	17	1115	*	0.26	101.42	-8.5	0.325	0.950	0.785	0.095	0.163
74	1978	4	22	15	1614	*	0.28	101.32	-13.4	0.479	0.960	0.830	0.085	0.198
75	1978	4	22	16	1519	*	0.25	101.33	-12.9	0.412	0.957	0.814	0.086	0.168
76	1978	4	22	17	1150	*	0.25	101.28	-11.8	0.330	0.951	0.787	0.092	0.151
77	1978	4	22	18	768	*	0.25	101.26	-11.5	0.238	0.940	0.745	0.101	0.124
78	1978	4	23	5	146	*	0.25	101.28	-18.6	0.058	0.873	0.557	0.142	0.036
79	1978	4	23	8	1188	*	0.28	101.35	-17.2	0.336	0.951	0.788	0.095	0.119
80	1978	4	23	9	1578	*	0.28	101.35	-15.9	0.417	0.957	0.815	0.089	0.116
81	1978	4	23	10	1889	*	0.26	101.38	-15.1	0.464	0.960	0.822	0.085	0.114
82	1978	4	23	11	2113	*	0.30	101.38	-13.8	0.531	0.962	0.842	0.084	0.101
83	1978	4	23	12	2237	*	0.30	101.38	-12.7	0.556	0.963	0.846	0.083	0.088
84	1978	4	23	13	2248	*	0.30	101.38	-11.4	0.556	0.963	0.846	0.083	0.068
85	1978	4	23	14	2148	*	0.20	101.42	-11.0	0.531	0.962	0.842	0.084	0.048
86	1978	4	23	15	1942	*	0.32	101.42	-10.3	0.484	0.960	0.832	0.088	0.028
87	1978	4	23	16	1617	*	0.30	101.42	-9.8	0.417	0.957	0.816	0.091	0.058
88	1978	4	23	17	1238	*	0.28	101.42	-10.3	0.336	0.951	0.790	0.094	0.073
89	1978	4	23	18	632	*	0.28	101.45	-10.3	0.244	0.941	0.748	0.103	0.076
90	1978	4	24	5	153	*	0.18	101.65	-18.1	0.065	0.877	0.568	0.127	0.054
91	1978	4	24	6	431	*	0.18	101.68	-21.3	0.158	0.922	0.688	0.103	0.120
92	1978	4	24	7	808	*	0.18	101.68	-22.4	0.250	0.941	0.754	0.081	0.142
93	1978	4	24	8	1192	*	0.18	101.75	-20.4	0.341	0.951	0.794	0.082	0.181
94	1978	4	24	9	1558	*	0.18	101.75	-20.3	0.423	0.957	0.819	0.077	0.206
95	1978	4	24	10	1877	*	0.18	101.75	-18.8	0.488	0.961	0.836	0.073	0.213
96	1978	4	24	11	2107	*	0.18	101.75	-18.1	0.538	0.963	0.845	0.071	0.210
97	1978	4	24	12	2237	*	0.18	101.75	-15.0	0.560	0.963	0.850	0.070	0.195
98	1978	4	24	13	2243	*	0.18	101.75	-12.3	0.560	0.963	0.850	0.070	0.184
99	1978	4	24	14	2137	*	0.18	101.75	-10.5	0.536	0.963	0.848	0.071	0.159
100	1978	4	24	15	1912	*	0.20	101.72	-8.6	0.488	0.961	0.835	0.076	0.146
101	1978	4	24	16	1617	*	0.20	101.72	-7.8	0.422	0.957	0.819	0.080	0.115
102	1978	4	24	17	1257	*	0.20	101.68	-7.8	0.341	0.951	0.794	0.085	0.094
103	1978	4	24	18	856	*	0.20	101.65	-7.3	0.250	0.941	0.753	0.093	0.068
104	1978	4	25	5	168	*	0.28	101.45	-14.8	0.070	0.881	0.578	0.141	0.050
105	1978	4	25	6	482	*	0.26	101.42	-15.8	0.161	0.923	0.691	0.118	0.098
106	1978	4	25	7	832	*	0.28	101.42	-15.9	0.255	0.942	0.755	0.102	0.122
107	1978	4	25	8	1198	*	0.28	101.42	-14.7	0.348	0.952	0.794	0.094	0.176
108	1978	4	25	9	1571	*	0.28	101.42	-12.5	0.427	0.957	0.818	0.088	0.181
109	1978	4	25	10	1872	*	0.28	101.38	-10.8	0.494	0.961	0.834	0.084	0.217
110	1978	4	25	11	2103	*	0.28	101.35	-9.1	0.541	0.963	0.843	0.082	0.207
111	1978	4	25	12	2218	*	0.28	101.35	-8.0	0.565	0.964	0.848	0.080	0.207
112	1978	4	25	13	2224	*	0.28	101.32	-6.3	0.565	0.964	0.848	0.080	0.195
113	1978	4	25	14	2143	*	0.28	101.32	-5.7	0.541	0.963	0.843	0.081	0.135
114	1978	4	25	15	1941	*	0.28	101.28	-5.3	0.494	0.961	0.833	0.084	0.103
115	1978	4	25	16	1629	*	0.28	101.25	-4.7	0.427	0.958	0.817	0.087	0.101
116	1978	4	25	17	1254	*	0.28	101.18	-4.3	0.348	0.952	0.782	0.093	0.103
117	1978	4	25	18	861	*	0.28	101.15	-3.5	0.255	0.942	0.753	0.102	0.090
118	1978	4	25	19	491	*	0.28	101.18	-4.2	0.161	0.923	0.690	0.115	0.064
119	1978	4	25	20	181	*	0.28	101.18	-4.2	0.070	0.881	0.577	0.140	0.028
120	1978	4	26	5	188	*	0.30	101.11	-11.0	0.075	0.885	0.588	0.142	0.038

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Inuvik

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
121	1978	4	28	6	478	*	0.30	101.05	-11.4	0.155	0.925	0.684	0.117	0.055
122	1978	4	28	7	820	*	0.33	101.11	-12.1	0.280	0.943	0.765	0.106	0.153
123	1978	4	28	8	1184	*	0.33	101.15	-11.0	0.351	0.952	0.783	0.098	0.213
124	1978	4	28	9	1571	*	0.36	101.15	-10.5	0.432	0.956	0.815	0.094	0.186
125	1978	4	28	10	1901	*	0.36	101.11	-8.7	0.489	0.961	0.833	0.090	0.172
126	1978	4	28	11	2108	*	0.38	101.08	-7.9	0.545	0.963	0.842	0.088	0.190
127	1978	4	28	12	2212	*	0.38	101.05	-7.6	0.570	0.964	0.847	0.085	0.214
128	1978	4	28	13	2201	*	0.41	101.01	-6.8	0.570	0.964	0.846	0.080	0.225
129	1978	4	28	14	2026	*	0.41	100.95	-5.6	0.545	0.963	0.841	0.081	0.344
130	1978	4	28	14	2137	*	0.56	100.17	4.8	0.555	0.964	0.827	0.100	0.141
131	1978	4	28	15	1901	*	0.56	100.17	5.1	0.508	0.962	0.826	0.102	0.173
132	1978	4	28	16	1600	*	0.56	100.17	6.6	0.442	0.959	0.813	0.106	0.153
133	1978	4	28	17	1230	*	0.56	100.20	7.6	0.380	0.953	0.790	0.111	0.152
134	1978	4	28	18	849	*	0.56	100.20	6.6	0.270	0.944	0.765	0.120	0.142
135	1978	4	28	19	481	*	0.56	100.20	5.3	0.175	0.928	0.686	0.135	0.107
136	1978	4	28	20	188	*	0.56	100.20	5.3	0.068	0.892	0.599	0.159	0.064
137	1978	4	28	20	231	*	0.71	100.34	0.5	0.081	0.895	0.607	0.157	0.040
138	1978	4	30	15	1861	*	0.56	100.57	-1.7	0.517	0.962	0.833	0.101	0.115
139	1978	4	30	16	1656	*	0.53	100.57	-1.3	0.451	0.959	0.816	0.104	0.092
140	1978	4	30	17	1306	*	0.51	100.54	-0.1	0.370	0.954	0.796	0.108	0.128
141	1978	4	30	18	830	*	0.51	100.54	0.3	0.280	0.948	0.751	0.117	0.100
142	1978	5	18	5	482	*	0.46	100.81	-5.7	0.167	0.929	0.694	0.132	0.104
143	1978	5	18	6	711	*	0.61	101.15	-2.0	0.282	0.946	0.757	0.128	0.274
144	1978	5	23	13	2553	*	0.56	101.42	-3.4	0.666	0.966	0.865	0.094	0.431
145	1978	5	23	14	2456	*	0.58	101.35	-1.8	0.644	0.966	0.861	0.095	0.371
146	1978	5	23	15	2253	*	0.56	101.32	-1.5	0.589	0.966	0.854	0.098	0.320
147	1978	5	23	16	1984	*	0.58	101.32	-0.6	0.525	0.964	0.842	0.102	0.288
148	1978	5	28	17	1652	*	0.74	101.79	-3.2	0.470	0.961	0.832	0.113	0.246
149	1978	5	28	18	1269	*	0.74	101.79	-2.3	0.363	0.957	0.806	0.120	0.185
150	1978	5	28	19	814	*	0.76	101.79	-1.9	0.253	0.949	0.775	0.130	0.181
151	1978	5	28	20	574	*	0.76	101.75	-1.1	0.206	0.937	0.728	0.142	0.137
152	1978	5	28	21	261	*	0.76	101.75	-0.7	0.128	0.917	0.681	0.160	0.136
153	1978	5	28	22	105	*	0.76	101.75	-0.7	0.065	0.882	0.570	0.183	0.104
154	1978	5	31	6	803	*	0.87	101.52	4.8	0.300	0.950	0.777	0.127	0.200
155	1978	5	31	8	1641	*	0.88	101.46	6.8	0.476	0.962	0.831	0.122	0.276
156	1978	5	31	9	1875	*	0.89	101.42	8.5	0.554	0.965	0.846	0.117	0.352
157	1978	5	31	21	322	*	1.30	100.66	17.5	0.136	0.920	0.685	0.178	0.088
158	1978	6	1	7	1268	0	1.70	100.41	10.6	0.392	0.960	0.802	0.147	0.057
159	1978	6	2	16	1301	0	0.86	101.06	5.6	0.394	0.960	0.807	0.123	0.094
160	1978	6	15	21	367	0	1.12	100.81	7.7	0.161	0.922	0.686	0.165	0.065
161	1978	6	15	22	217	0	1.12	100.86	7.2	0.098	0.910	0.619	0.183	0.048
162	1978	6	15	23	100	0	1.14	100.81	6.5	0.054	0.881	0.544	0.204	0.037
163	1978	6	16	19	1006	0	0.94	100.20	16.1	0.324	0.956	0.776	0.132	0.080
164	1978	6	16	20	686	0	0.91	100.24	13.4	0.238	0.947	0.739	0.142	0.078
165	1978	6	16	21	426	0	0.88	100.27	11.3	0.161	0.933	0.686	0.156	0.055
166	1978	6	16	22	223	0	0.88	100.27	9.3	0.090	0.911	0.618	0.171	0.046
167	1978	6	17	15	2034	0	0.88	100.76	8.6	0.575	0.966	0.846	0.111	0.121
168	1978	6	17	17	1717	0	0.89	100.76	9.6	0.498	0.965	0.821	0.116	0.109
169	1978	6	17	18	1385	0	0.91	100.78	10.6	0.412	0.961	0.810	0.123	0.098
170	1978	6	17	19	998	0	0.94	100.81	10.7	0.324	0.958	0.782	0.132	0.103
171	1978	6	17	22	100	0	1.04	100.78	6.6	0.055	0.862	0.547	0.189	0.043
172	1978	6	30	21	387	0	1.57	99.77	23.0	0.150	0.933	0.682	0.177	0.071
173	1978	6	30	22	193	0	1.55	99.77	22.7	0.087	0.910	0.613	0.195	0.063
174	1978	6	30	23	82	0	1.58	99.77	21.6	0.053	0.881	0.536	0.219	0.052
175	1978	7	3	10	2236	0	1.80	99.97	14.8	0.634	0.971	0.849	0.123	0.076
176	1978	7	4	8	1081	0	1.75	100.41	14.4	0.316	0.954	0.777	0.158	0.093
177	1978	7	5	16	1365	0	0.75	101.45	17.5	0.405	0.963	0.812	0.116	0.086
178	1978	7	5	19	996	0	0.79	101.45	16.1	0.317	0.957	0.783	0.127	0.086
179	1978	7	5	20	668	0	0.79	101.42	16.2	0.231	0.946	0.741	0.138	0.077
180	1978	7	5	21	387	0	0.79	101.38	16.1	0.164	0.934	0.685	0.152	0.072

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
181	1978	7	8	22	152	0	0.79	101.38	17.8	0.051	0.813	0.512	0.171	0.035
182	1978	7	8	23	82	0	0.81	101.38	15.7	0.048	0.881	0.521	0.192	0.042
183	1978	7	8	2	82	0	0.81	101.42	13.8	0.045	0.878	0.527	0.184	0.037
184	1978	7	8	3	193	0	0.84	101.42	12.1	0.089	0.911	0.610	0.174	0.051
185	1978	7	8	4	393	0	0.84	101.45	10.3	0.152	0.934	0.684	0.158	0.061
186	1978	7	8	5	651	0	0.84	101.48	10.8	0.229	0.948	0.741	0.141	0.085
187	1978	7	8	6	990	0	0.84	101.48	10.8	0.315	0.957	0.782	0.130	0.084
188	1978	7	8	7	1348	0	0.84	101.48	11.2	0.404	0.963	0.813	0.121	0.091
189	1978	7	8	8	1708	0	0.84	101.48	11.8	0.490	0.966	0.834	0.115	0.094
190	1978	7	8	9	2039	0	0.86	101.45	13.2	0.567	0.969	0.848	0.111	0.097
191	1978	7	8	10	2297	0	0.88	101.45	14.4	0.630	0.971	0.858	0.108	0.100
192	1978	7	8	11	2502	0	0.88	101.42	15.8	0.675	0.971	0.865	0.106	0.094
193	1978	7	8	12	2602	0	0.88	101.38	16.8	0.698	0.972	0.868	0.105	0.093
194	1978	7	8	13	2602	0	0.88	101.35	18.6	0.698	0.972	0.868	0.105	0.092
195	1978	7	8	14	2497	0	0.88	101.35	19.4	0.675	0.972	0.865	0.105	0.088
196	1978	7	8	15	2315	0	0.89	101.32	20.3	0.630	0.971	0.858	0.106	0.078
197	1978	7	8	16	2045	0	0.91	101.25	20.8	0.567	0.969	0.848	0.112	0.075
198	1978	7	8	17	1717	0	0.94	101.21	22.1	0.490	0.966	0.832	0.118	0.074
199	1978	7	8	18	1360	0	0.97	101.21	21.8	0.404	0.963	0.811	0.128	0.072
200	1978	7	8	19	985	0	0.99	101.18	22.4	0.315	0.957	0.780	0.135	0.081
201	1978	7	8	20	656	0	1.02	101.11	22.8	0.229	0.948	0.739	0.147	0.074
202	1978	7	8	21	375	0	1.04	101.11	22.2	0.152	0.934	0.682	0.163	0.073
203	1978	7	8	22	175	0	1.07	101.11	21.9	0.088	0.911	0.606	0.183	0.065
204	1978	7	8	23	70	0	1.08	101.08	21.2	0.045	0.880	0.526	0.206	0.050
205	1978	7	8	22	175	0	1.04	100.88	22.2	0.086	0.909	0.602	0.183	0.054
206	1978	7	8	23	70	0	1.02	100.98	18.9	0.041	0.876	0.517	0.205	0.040
207	1978	7	9	14	2414	0	1.80	101.21	12.8	0.671	0.971	0.863	0.128	0.091
208	1978	7	9	15	2200	0	1.86	101.21	14.2	0.626	0.970	0.857	0.130	0.106
209	1978	7	9	16	1940	0	1.88	101.18	15.7	0.563	0.968	0.846	0.133	0.109
210	1978	7	9	17	1605	0	1.88	101.18	17.4	0.486	0.965	0.831	0.139	0.243
211	1978	7	11	21	382	0	0.94	100.81	17.8	0.143	0.932	0.671	0.181	0.086
212	1978	7	11	22	184	0	0.94	100.81	16.8	0.080	0.906	0.591	0.182	0.050
213	1978	7	12	3	182	0	0.89	100.51	8.4	0.078	0.905	0.587	0.188	0.055
214	1978	7	12	4	348	0	0.87	100.47	8.2	0.141	0.931	0.668	0.163	0.084
215	1978	7	12	5	586	0	0.87	100.44	8.3	0.218	0.947	0.728	0.147	0.101
216	1978	7	12	6	926	0	0.87	100.41	8.6	0.305	0.957	0.771	0.135	0.098
217	1978	7	12	7	1272	0	0.87	100.41	10.0	0.394	0.962	0.802	0.126	0.110
218	1978	7	12	8	1623	0	0.87	100.37	11.3	0.481	0.966	0.824	0.120	0.121
219	1978	7	12	9	1946	0	0.87	100.34	12.8	0.558	0.969	0.839	0.115	0.126
220	1978	7	12	10	2315	0	0.87	100.31	13.8	0.621	0.970	0.849	0.111	0.127
221	1978	7	12	11	2409	0	0.87	100.27	15.2	0.666	0.971	0.858	0.109	0.128
222	1978	7	12	12	2620	0	0.87	100.27	17.0	0.688	0.972	0.869	0.108	0.112
223	1978	7	12	13	2632	0	0.87	100.24	18.2	0.689	0.972	0.858	0.108	0.097
224	1978	7	12	14	2438	0	0.87	100.20	18.3	0.666	0.971	0.855	0.109	0.090
225	1978	7	12	15	2260	0	0.87	100.17	20.0	0.621	0.970	0.848	0.111	0.086
226	1978	7	12	16	1975	0	0.87	100.14	19.8	0.558	0.969	0.838	0.114	0.093
227	1978	7	12	17	1668	0	0.87	100.07	20.2	0.481	0.966	0.822	0.119	0.084
228	1978	7	12	18	1318	0	0.87	100.04	20.1	0.394	0.962	0.800	0.126	0.086
229	1978	7	12	19	955	0	0.87	99.97	20.4	0.305	0.957	0.769	0.134	0.089
230	1978	7	12	20	621	0	0.87	99.94	20.3	0.218	0.947	0.728	0.148	0.089
231	1978	7	12	21	348	0	0.88	99.90	18.8	0.141	0.932	0.665	0.163	0.083
232	1978	7	12	22	182	0	0.88	99.90	17.7	0.078	0.906	0.585	0.184	0.055
233	1978	7	13	3	182	0	1.02	99.80	10.8	0.075	0.904	0.581	0.187	0.048
234	1978	7	13	4	334	0	0.88	99.80	10.1	0.136	0.931	0.663	0.164	0.067
235	1978	7	13	5	586	0	0.89	99.84	9.8	0.218	0.947	0.724	0.148	0.081
236	1978	7	13	6	897	0	0.89	99.92	9.4	0.303	0.956	0.767	0.136	0.113
237	1978	7	13	7	1218	0	0.87	99.94	11.4	0.382	0.962	0.798	0.128	0.154
238	1978	7	18	6	823	0	1.07	101.28	5.7	0.291	0.944	0.722	0.158	0.068
239	1978	7	18	7	1213	0	1.07	101.28	6.8	0.378	0.961	0.803	0.132	0.102
240	1978	7	18	8	1589	0	1.07	101.25	8.4	0.486	0.965	0.827	0.128	0.118

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
241	1978	7	18	9	1883	0	1.07	101.25	9.9	0.843	0.968	0.843	0.120	0.118
242	1978	7	18	10	2182	0	1.07	101.25	12.2	0.807	0.970	0.854	0.118	0.118
243	1978	7	18	11	2365	0	1.07	101.21	14.3	0.852	0.971	0.861	0.113	0.118
244	1978	7	18	12	2467	0	1.07	101.18	15.8	0.878	0.972	0.864	0.112	0.103
245	1978	7	18	13	2467	0	1.07	101.15	17.5	0.878	0.972	0.864	0.112	0.102
246	1978	7	18	14	2373	0	1.07	101.08	18.3	0.852	0.971	0.860	0.113	0.098
247	1978	7	18	15	2188	0	1.07	101.05	20.1	0.807	0.970	0.853	0.115	0.090
248	1978	7	18	16	1889	0	1.08	100.98	20.3	0.843	0.968	0.841	0.120	0.105
249	1978	7	27	8	1484	0	1.80	100.27	17.2	0.821	0.966	0.832	0.126	0.098
250	1978	7	28	7	650	0	1.88	100.86	10.2	0.347	0.960	0.781	0.157	0.377
251	1978	7	31	18	686	0	2.31	101.32	24.3	0.248	0.951	0.751	0.176	0.063
252	1978	7	31	20	404	0	2.28	101.25	23.7	0.160	0.936	0.690	0.194	0.052
253	1978	8	1	5	253	0	2.21	101.11	17.2	0.158	0.939	0.686	0.193	0.060
254	1978	8	1	6	668	0	2.26	101.08	17.2	0.248	0.953	0.747	0.176	0.090
255	1978	8	1	7	1020	0	2.24	101.05	17.4	0.338	0.961	0.788	0.162	0.090
256	1978	8	1	9	1723	0	2.28	100.95	16.4	0.504	0.968	0.833	0.148	0.063
257	1978	8	1	10	1840	0	2.28	100.91	18.5	0.568	0.970	0.848	0.144	0.244
258	1978	8	10	18	826	0	0.88	100.61	12.5	0.288	0.958	0.770	0.133	0.087
259	1978	8	10	19	574	0	0.88	100.61	12.6	0.207	0.946	0.722	0.146	0.079
260	1978	8	10	20	276	0	0.88	100.57	12.3	0.117	0.928	0.642	0.187	0.059
261	1978	8	11	6	598	0	0.88	100.76	0.3	0.202	0.947	0.720	0.146	0.046
262	1978	8	11	7	949	0	0.88	100.76	1.5	0.285	0.956	0.770	0.124	0.054
263	1978	8	11	14	1868	0	0.94	100.66	12.2	0.578	0.971	0.848	0.113	0.225
264	1978	8	11	15	1852	0	0.97	100.66	13.0	0.531	0.969	0.837	0.116	0.121
265	1978	8	11	16	1547	0	0.94	100.51	13.0	0.465	0.967	0.822	0.120	0.150
266	1978	8	11	19	551	0	0.81	100.47	14.2	0.202	0.948	0.718	0.148	0.083
267	1978	8	11	20	252	0	0.88	100.41	14.8	0.112	0.926	0.630	0.186	0.086
268	1978	8	12	5	234	0	0.84	100.17	4.6	0.107	0.924	0.629	0.186	0.070
269	1978	8	12	11	2038	0	0.81	99.90	11.9	0.573	0.971	0.838	0.112	0.115
270	1978	8	12	12	2151	0	0.91	99.87	13.7	0.598	0.971	0.842	0.111	0.107
271	1978	8	12	13	2148	0	0.94	99.83	15.7	0.598	0.971	0.842	0.111	0.111
272	1978	8	12	14	2048	0	0.94	99.77	16.2	0.573	0.971	0.838	0.112	0.106
273	1978	8	12	15	1868	0	0.97	99.73	16.6	0.527	0.969	0.829	0.116	0.103
274	1978	8	12	16	1585	0	0.97	99.67	17.2	0.461	0.967	0.818	0.120	0.105
275	1978	8	16	19	457	0	1.07	101.21	6.3	0.178	0.943	0.704	0.159	0.085
276	1978	8	17	5	211	0	1.04	101.28	0.3	0.092	0.912	0.598	0.187	0.017
277	1978	8	17	20	152	0	0.68	101.42	6.6	0.062	0.912	0.598	0.189	0.082
278	1978	8	18	6	428	0	0.75	101.45	0.1	0.168	0.941	0.697	0.149	0.088
279	1978	8	18	7	756	0	0.81	101.42	-0.6	0.282	0.955	0.758	0.136	0.112
280	1978	8	18	8	1061	0	0.84	101.42	3.4	0.352	0.962	0.796	0.126	0.178
281	1978	8	18	9	1459	0	0.86	101.38	5.6	0.434	0.966	0.820	0.120	0.118
282	1978	8	18	20	122	0	1.52	100.31	16.1	0.072	0.906	0.578	0.206	0.067
283	1978	8	20	5	123	0	1.52	99.80	11.2	0.066	0.903	0.565	0.208	0.040
284	1978	8	20	6	361	0	1.50	99.73	10.9	0.157	0.939	0.679	0.176	0.076
285	1978	8	20	7	692	0	1.45	99.63	10.4	0.251	0.954	0.742	0.157	0.111
286	1978	8	20	8	1049	0	1.42	99.57	11.2	0.343	0.962	0.780	0.145	0.111
287	1978	8	20	9	1389	0	1.40	99.50	11.6	0.424	0.966	0.804	0.136	0.104
288	1978	8	20	17	1067	0	1.24	99.03	21.4	0.342	0.962	0.777	0.139	0.100
289	1978	8	20	18	715	0	1.30	98.99	21.7	0.251	0.954	0.738	0.151	0.092
290	1978	8	29	12	1784	0	1.63	100.27	16.2	0.517	0.969	0.832	0.136	0.116
291	1978	8	29	13	1770	0	1.57	100.34	18.4	0.517	0.969	0.831	0.134	0.115
292	1978	8	29	14	1670	0	1.52	100.31	20.2	0.492	0.968	0.828	0.134	0.112
293	1978	8	29	15	1485	0	1.50	100.31	21.3	0.445	0.966	0.815	0.137	0.118
294	1978	9	2	7	481	0	1.52	100.27	5.2	0.180	0.946	0.701	0.173	0.085
295	1978	9	2	8	787	0	1.47	100.31	4.6	0.273	0.956	0.757	0.156	0.095
296	1978	9	2	17	803	0	1.04	100.34	15.6	0.273	0.956	0.757	0.142	0.104
297	1978	9	3	7	475	0	0.86	100.37	6.1	0.178	0.945	0.697	0.151	0.088
298	1978	9	3	13	1752	0	0.84	100.34	11.7	0.490	0.968	0.826	0.114	0.073
299	1978	9	3	14	1641	0	0.84	100.31	13.1	0.465	0.968	0.820	0.118	0.078
300	1978	9	3	15	1442	0	0.84	100.27	14.0	0.417	0.967	0.806	0.119	0.075

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
301	1978	9	3	15	1164	0	0.84	100.27	14.5	0.350	0.853	0.787	0.125	0.056
302	1978	9	3	17	815	0	0.88	100.24	15.2	0.287	0.857	0.754	0.126	0.060
303	1978	9	12	7	281	0	1.50	100.61	1.8	0.121	0.832	0.647	0.188	0.061
304	1978	9	12	8	580	0	1.50	100.57	2.2	0.214	0.851	0.726	0.186	0.080
305	1978	9	12	9	885	0	1.50	100.57	3.3	0.287	0.860	0.779	0.153	0.106
306	1978	9	12	10	1168	0	1.47	100.51	5.0	0.365	0.864	0.784	0.145	0.101
307	1978	9	12	12	1471	0	1.47	100.41	8.3	0.438	0.867	0.814	0.138	0.100
308	1978	10	13	9	205	*	0.43	101.25	-13.2	0.102	0.823	0.627	0.145	0.157
309	1978	10	13	10	475	*	0.43	101.15	-12.8	0.170	0.843	0.688	0.128	0.132
310	1978	10	13	11	645	*	0.43	101.08	-12.5	0.218	0.851	0.732	0.121	0.170
311	1978	10	13	12	703	*	0.43	101.01	-11.4	0.243	0.854	0.748	0.117	0.239
312	1978	10	13	13	703	*	0.43	101.01	-11.1	0.243	0.854	0.745	0.117	0.239
313	1978	10	13	14	604	*	0.43	100.95	-10.3	0.218	0.851	0.731	0.120	0.232
314	1978	10	13	15	434	*	0.46	100.88	-9.2	0.170	0.843	0.688	0.130	0.189
315	1978	10	13	16	260	*	0.48	100.78	-8.5	0.102	0.824	0.625	0.147	0.101
316	1978	10	14	10	422	*	0.41	100.88	-14.7	0.164	0.842	0.651	0.126	0.172
317	1978	10	14	11	621	*	0.38	100.88	-14.8	0.212	0.850	0.726	0.117	0.189
318	1978	10	14	12	738	*	0.38	100.88	-13.1	0.238	0.853	0.741	0.114	0.157
319	1978	10	14	13	709	*	0.38	100.84	-11.2	0.228	0.853	0.741	0.111	0.199
320	1978	10	14	14	608	*	0.38	100.81	-9.3	0.212	0.850	0.720	0.118	0.188
321	1978	10	14	15	428	*	0.36	100.78	-9.3	0.164	0.842	0.651	0.123	0.167
322	1978	10	14	16	188	*	0.36	100.71	-8.7	0.085	0.821	0.616	0.139	0.142
323	1978	10	16	11	855	*	0.45	100.84	-17.8	0.199	0.848	0.718	0.125	-0.078
324	1978	10	16	12	1080	*	0.45	100.81	-14.8	0.224	0.851	0.734	0.122	-0.152
325	1978	10	16	13	973	*	0.46	100.84	-12.6	0.224	0.851	0.734	0.121	-0.089
326	1978	11	17	12	141	*	0.25	102.63	-23.3	0.047	0.862	0.537	0.149	0.017
327	1978	11	17	13	128	*	0.23	102.63	-24.2	0.047	0.862	0.537	0.145	0.029
328	1978	11	18	12	86	*	0.30	102.63	-17.8	0.043	0.878	0.528	0.158	0.060
329	1978	11	18	13	82	*	0.30	102.53	-17.0	0.043	0.878	0.527	0.156	0.070
330	1979	2	12	14	287	*	0.08	103.23	-33.6	0.107	0.902	0.643	0.090	0.102
331	1979	2	13	11	381	*	0.08	102.28	-34.8	0.113	0.908	0.645	0.088	0.032
332	1979	2	13	12	463	*	0.08	102.28	-32.6	0.137	0.915	0.674	0.084	0.046
333	1979	2	13	13	463	*	0.08	102.28	-32.6	0.137	0.915	0.673	0.084	0.046
334	1979	2	13	14	387	*	0.08	102.28	-34.2	0.113	0.908	0.646	0.089	0.028
335	1979	2	13	15	217	*	0.08	102.26	-33.9	0.065	0.878	0.574	0.101	0.017
336	1979	2	20	12	588	*	0.23	102.05	-30.3	0.179	0.928	0.710	0.108	0.073
337	1979	2	20	13	583	*	0.23	102.12	-28.7	0.179	0.928	0.710	0.108	0.084
338	1979	2	20	14	488	*	0.23	102.18	-25.5	0.155	0.921	0.690	0.112	0.089
339	1979	2	20	15	318	*	0.23	102.28	-25.2	0.107	0.903	0.638	0.123	0.049
340	1979	2	20	16	82	*	0.20	102.28	-24.5	0.040	0.858	0.520	0.145	0.069
341	1979	2	28	14	533	*	0.20	101.75	-23.0	0.182	0.931	0.718	0.102	0.203
342	1979	2	28	15	211	*	0.18	101.88	-22.1	0.077	0.888	0.582	0.123	0.044
343	1979	3	1	14	887	*	0.13	101.89	-31.9	0.211	0.924	0.733	0.088	-0.025
344	1979	3	1	15	718	*	0.13	101.88	-31.8	0.153	0.923	0.597	0.083	-0.058
345	1979	3	4	14	703	*	0.08	101.88	-30.4	0.230	0.938	0.744	0.072	0.233
346	1979	3	4	15	538	*	0.08	101.85	-30.3	0.182	0.928	0.712	0.077	0.189
347	1979	3	4	16	334	*	0.08	101.82	-30.1	0.118	0.906	0.646	0.088	0.077
348	1979	3	10	14	897	*	0.10	102.29	-35.7	0.259	0.943	0.787	0.075	0.197
349	1979	3	10	15	732	*	0.10	102.29	-34.3	0.221	0.936	0.741	0.080	0.129
350	1979	3	10	16	482	*	0.10	102.29	-33.9	0.153	0.920	0.689	0.089	0.071
351	1979	3	17	13	1442	*	0.15	100.56	-28.4	0.340	0.951	0.788	0.079	-0.048
352	1979	3	17	14	1231	*	0.15	100.57	-26.0	0.315	0.949	0.776	0.080	0.038
353	1979	3	17	15	938	*	0.15	100.57	-26.3	0.287	0.944	0.755	0.084	0.106
354	1979	3	17	16	621	*	0.15	100.51	-25.8	0.198	0.932	0.718	0.082	0.121
355	1979	3	21	11	1242	*	0.20	102.63	-26.9	0.341	0.951	0.800	0.087	0.144
356	1979	3	21	12	1328	*	0.20	102.63	-27.6	0.388	0.953	0.808	0.085	0.171
357	1979	3	21	13	1368	*	0.20	102.63	-27.4	0.388	0.953	0.808	0.085	0.156
358	1979	3	21	14	1272	*	0.20	102.58	-26.7	0.341	0.951	0.799	0.087	0.109
359	1979	3	21	15	1014	*	0.20	102.55	-25.9	0.292	0.946	0.780	0.081	0.148
360	1979	3	29	11	1465	*	0.10	102.15	-21.5	0.391	0.955	0.813	0.087	0.196

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
361	1979	3	29	12	1884	*	0.10	102.28	-30.1	0.416	0.956	0.821	0.085	0.086
362	1979	3	29	13	1884	*	0.10	102.29	-28.9	0.416	0.956	0.821	0.085	0.086
363	1979	3	29	14	1471	*	0.10	102.38	-26.7	0.391	0.955	0.815	0.087	0.189
364	1979	3	29	15	1248	*	0.10	102.43	-28.2	0.342	0.951	0.799	0.088	0.177
365	1979	3	29	16	920	*	0.10	102.49	-27.3	0.275	0.944	0.771	0.074	0.184
366	1979	3	30	8	898	*	0.13	102.48	-37.1	0.197	0.931	0.726	0.089	0.149
367	1979	3	30	9	832	*	0.15	102.48	-36.2	0.261	0.946	0.774	0.084	0.168
368	1979	3	30	10	1242	*	0.15	102.46	-30.2	0.348	0.951	0.802	0.079	0.200
369	1979	3	30	11	1489	*	0.15	102.43	-28.8	0.397	0.955	0.817	0.075	0.178
370	1979	3	30	12	1884	*	0.15	102.43	-25.1	0.422	0.957	0.824	0.074	0.202
371	1979	3	30	13	1805	*	0.15	102.39	-24.6	0.422	0.957	0.824	0.074	0.184
372	1979	3	30	14	1485	*	0.15	102.39	-22.3	0.387	0.955	0.817	0.075	0.212
373	1979	3	30	15	1286	*	0.16	102.38	-20.9	0.349	0.952	0.801	0.082	0.158
374	1979	3	30	16	987	*	0.15	102.39	-19.6	0.261	0.945	0.773	0.084	0.142
375	1979	3	30	17	821	*	0.15	102.28	-18.3	0.197	0.931	0.725	0.093	0.114
376	1979	3	30	18	275	*	0.15	102.28	-19.1	0.104	0.901	0.636	0.110	0.078
377	1979	4	12	8	1111	*	0.22	102.83	-34.4	0.276	0.944	0.774	0.086	-0.029
378	1979	4	12	13	2272	*	0.23	102.78	-25.0	0.488	0.961	0.848	0.080	-0.218
379	1979	4	17	7	683	*	0.25	101.55	-28.1	0.212	0.935	0.731	0.106	0.221
380	1979	4	17	8	1057	*	0.26	101.55	-27.3	0.304	0.948	0.778	0.095	0.124
381	1979	4	17	9	1408	*	0.26	101.58	-24.8	0.388	0.955	0.806	0.091	0.152
382	1979	4	17	10	1714	*	0.25	101.55	-23.0	0.453	0.959	0.826	0.087	0.187
383	1979	4	17	11	1985	*	0.28	101.58	-21.6	0.501	0.961	0.837	0.084	0.145
384	1979	4	17	12	2070	*	0.28	101.55	-20.0	0.525	0.962	0.842	0.083	0.149
385	1979	4	17	13	2070	*	0.28	101.55	-17.4	0.525	0.962	0.842	0.083	0.148
386	1979	4	17	14	1988	*	0.28	101.52	-15.8	0.501	0.961	0.837	0.084	0.144
387	1979	4	17	15	1728	*	0.30	101.52	-15.5	0.453	0.959	0.826	0.088	0.136
388	1979	4	17	16	1413	*	0.30	101.52	-14.2	0.388	0.955	0.807	0.093	0.140
389	1979	4	17	17	1052	*	0.33	101.45	-14.2	0.304	0.948	0.778	0.102	0.116
390	1979	4	17	18	627	*	0.38	101.42	-13.6	0.212	0.936	0.730	0.115	0.142
391	1979	4	18	6	386	*	0.41	101.08	-16.6	0.123	0.910	0.651	0.146	0.060
392	1979	4	18	7	642	*	0.51	101.01	-17.3	0.217	0.936	0.731	0.126	0.136
393	1979	4	18	8	1057	*	0.51	100.98	-14.6	0.309	0.948	0.777	0.116	0.112
394	1979	4	18	9	1442	*	0.51	100.95	-11.2	0.391	0.955	0.805	0.107	0.093
395	1979	4	18	14	1817	*	0.48	100.91	-3.7	0.506	0.962	0.833	0.096	0.177
396	1979	4	18	15	1709	*	0.48	100.91	-3.3	0.458	0.959	0.823	0.101	0.152
397	1979	4	18	16	1406	*	0.48	100.91	-2.4	0.391	0.955	0.805	0.105	0.139
398	1979	4	18	17	1037	*	0.51	100.91	-4.4	0.309	0.948	0.776	0.114	0.135
399	1979	4	18	18	627	*	0.53	100.85	-5.2	0.217	0.936	0.731	0.127	0.154
400	1979	4	25	7	658	*	0.68	101.21	-2.4	0.270	0.944	0.761	0.136	0.109
401	1979	4	30	9	1585	*	0.81	101.78	0.7	0.451	0.958	0.827	0.121	0.200
402	1979	4	30	10	1863	*	0.81	101.75	1.6	0.517	0.963	0.842	0.117	0.235
403	1979	4	30	14	2080	*	0.84	101.70	5.1	0.564	0.964	0.851	0.115	0.276
404	1979	4	30	15	1872	*	0.87	101.79	5.7	0.517	0.962	0.842	0.118	0.247
405	1979	4	30	16	1571	*	0.84	101.78	6.4	0.451	0.959	0.827	0.122	0.239
406	1979	4	30	17	1280	*	0.84	101.70	6.4	0.370	0.954	0.804	0.128	0.163
407	1979	4	30	18	884	*	0.81	101.75	5.6	0.280	0.945	0.769	0.137	0.128
408	1979	4	30	19	519	*	0.81	101.75	6.7	0.186	0.930	0.714	0.152	0.105
409	1979	4	30	20	217	*	0.80	101.73	6.7	0.068	0.887	0.621	0.178	0.071
410	1979	5	1	5	233	0	0.78	101.88	-1.1	0.101	0.905	0.627	0.189	0.051
411	1979	5	1	6	514	0	0.78	101.83	-1.8	0.191	0.934	0.717	0.148	0.068
412	1979	5	1	7	874	0	0.74	101.73	-2.3	0.284	0.948	0.771	0.130	0.092
413	1979	5	1	10	1836	0	0.68	101.89	-1.2	0.521	0.964	0.842	0.106	0.042
414	1979	5	1	14	2159	0	0.58	101.65	3.1	0.568	0.965	0.851	0.099	0.035
415	1979	5	1	15	1971	0	0.58	101.62	2.6	0.521	0.964	0.842	0.101	0.022
416	1979	5	1	16	1658	0	0.53	101.53	4.1	0.455	0.961	0.827	0.104	0.053
417	1979	5	1	17	1234	0	0.53	101.55	4.2	0.375	0.956	0.804	0.110	0.035
418	1979	5	1	18	946	0	0.53	101.55	4.4	0.284	0.948	0.770	0.118	0.044
419	1979	5	1	19	583	0	0.53	101.55	4.2	0.181	0.934	0.716	0.121	0.038
420	1979	5	1	20	252	0	0.53	101.55	3.6	0.101	0.905	0.627	0.153	0.038

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
421	1979	5	2	5	272	0	0.53	101.75	-5.8	0.108	0.907	0.834	0.152	0.037
422	1979	5	2	15	2015	0	0.58	101.55	1.5	0.528	0.984	0.842	0.107	-0.014
423	1979	5	2	16	1898	0	0.58	101.52	2.1	0.460	0.981	0.827	0.110	0.019
424	1979	5	2	17	1383	0	0.53	101.45	3.2	0.378	0.956	0.808	0.115	0.019
425	1979	5	2	18	883	0	0.53	101.42	2.8	0.288	0.940	0.771	0.124	0.028
426	1979	5	2	19	598	0	0.51	101.42	3.4	0.198	0.935	0.718	0.135	0.038
427	1979	5	2	20	272	0	0.51	101.38	2.8	0.108	0.907	0.832	0.155	0.035
428	1979	5	3	5	272	0	0.53	101.28	-3.3	0.111	0.910	0.836	0.150	0.061
429	1979	5	3	6	585	0	0.53	101.25	-3.7	0.201	0.936	0.72	0.130	0.058
430	1979	5	3	7	988	0	0.53	101.28	-2.9	0.294	0.949	0.772	0.117	0.041
431	1979	5	3	8	1373	0	0.53	101.25	-3.1	0.384	0.957	0.808	0.108	0.033
432	1979	5	3	9	1724	0	0.53	101.21	-1.8	0.464	0.981	0.828	0.103	0.023
433	1979	5	3	10	2015	0	0.53	101.18	-0.2	0.530	0.984	0.840	0.099	0.014
434	1979	5	3	11	2213	0	0.53	101.15	1.4	0.577	0.988	0.848	0.097	0.018
435	1979	5	3	12	2317	0	0.53	101.11	2.8	0.601	0.988	0.852	0.095	0.015
436	1979	5	3	13	2302	0	0.53	101.08	3.4	0.601	0.988	0.852	0.095	0.030
437	1979	5	3	14	2193	0	0.53	101.05	4.7	0.577	0.988	0.848	0.095	0.034
438	1979	5	3	15	1996	0	0.53	100.98	4.8	0.530	0.984	0.839	0.099	0.030
439	1979	5	3	16	1694	0	0.53	100.95	5.2	0.464	0.981	0.824	0.103	0.048
440	1979	5	4	5	277	0	0.74	100.57	-0.5	0.115	0.912	0.841	0.150	0.055
441	1979	5	4	8	1348	0	0.76	100.51	-0.3	0.388	0.957	0.801	0.120	0.068
442	1979	5	4	9	1688	0	0.79	100.51	0.3	0.468	0.982	0.822	0.115	0.041
443	1979	5	4	10	1876	0	0.79	100.47	1.4	0.534	0.984	0.836	0.110	0.033
444	1979	5	4	11	2173	0	0.81	100.44	3.0	0.581	0.988	0.844	0.108	0.031
445	1979	5	4	12	2272	0	0.81	100.41	3.0	0.605	0.987	0.848	0.107	0.034
446	1979	5	4	13	2267	0	0.84	100.41	3.8	0.608	0.987	0.848	0.108	0.037
447	1979	5	4	14	2158	0	0.84	100.41	4.3	0.581	0.988	0.844	0.108	0.042
448	1979	5	4	15	1981	0	0.88	100.41	5.1	0.534	0.984	0.838	0.113	0.040
449	1979	5	4	16	1680	0	0.84	100.41	5.7	0.468	0.982	0.822	0.118	0.063
450	1979	5	4	17	1339	0	0.84	100.41	5.8	0.368	0.957	0.801	0.123	0.048
451	1979	5	4	18	983	0	0.84	100.41	7.0	0.298	0.950	0.768	0.131	0.055
452	1979	5	4	19	598	0	0.81	100.27	7.2	0.208	0.938	0.730	0.143	0.058
453	1979	5	5	7	993	0	0.58	100.68	-0.5	0.303	0.951	0.772	0.123	0.058
454	1979	5	5	8	1368	0	0.53	100.68	-0.2	0.392	0.958	0.804	0.113	0.054
455	1979	5	5	9	1724	0	0.53	100.68	0.2	0.473	0.982	0.824	0.108	0.039
456	1979	5	5	10	2020	0	0.51	100.74	1.5	0.538	0.984	0.838	0.102	0.028
457	1979	5	5	11	2223	0	0.58	100.71	2.7	0.585	0.988	0.847	0.093	0.028
458	1979	5	5	12	2312	0	0.58	100.71	3.2	0.608	0.987	0.850	0.098	0.048
459	1979	5	5	13	2302	0	0.53	100.71	4.8	0.608	0.987	0.850	0.095	0.060
460	1979	5	5	14	2193	0	0.51	100.71	5.1	0.585	0.988	0.847	0.094	0.070
461	1979	5	5	15	2015	0	0.51	100.74	5.8	0.528	0.984	0.838	0.097	0.048
462	1979	5	5	16	1724	0	0.48	100.78	7.2	0.473	0.982	0.825	0.098	0.058
463	1979	5	5	17	1398	0	0.48	100.78	7.2	0.393	0.957	0.804	0.104	0.043
464	1979	5	5	18	1013	0	0.48	100.74	7.2	0.303	0.950	0.773	0.111	0.053
465	1979	5	5	19	642	0	0.48	100.74	8.3	0.210	0.938	0.728	0.122	0.051
466	1979	5	5	20	315	0	0.43	100.74	8.1	0.120	0.914	0.647	0.138	0.044
467	1979	5	8	4	116	0	0.38	101.01	-4.5	0.045	0.888	0.528	0.184	0.012
468	1979	5	8	5	331	0	0.41	101.08	-6.0	0.128	0.918	0.654	0.136	0.047
469	1979	5	8	6	682	0	0.41	101.15	-6.7	0.218	0.938	0.730	0.118	0.080
470	1979	5	8	7	1037	0	0.43	101.18	-7.1	0.307	0.951	0.777	0.110	0.051
471	1979	5	8	8	1418	0	0.43	101.28	-7.0	0.397	0.958	0.808	0.103	0.047
472	1979	5	8	9	1788	0	0.48	101.38	-5.5	0.477	0.982	0.830	0.098	0.036
473	1979	5	8	10	2080	0	0.48	101.38	-5.5	0.542	0.984	0.844	0.094	0.040
474	1979	5	8	11	2247	0	0.48	101.35	-4.3	0.589	0.988	0.852	0.094	0.040
475	1979	5	8	12	2341	0	0.48	101.38	-3.8	0.613	0.987	0.855	0.093	0.051
476	1979	5	10	16	1808	0	0.46	100.74	-1.6	0.483	0.983	0.829	0.097	0.058
477	1979	5	10	17	1383	0	0.48	100.88	-0.1	0.413	0.959	0.809	0.102	0.133
478	1979	5	10	18	1077	0	0.48	100.84	-0.3	0.324	0.952	0.781	0.108	0.070
479	1979	5	10	19	711	0	0.46	100.81	0.8	0.232	0.942	0.737	0.118	0.083
480	1979	5	10	20	385	0	0.48	100.81	0.4	0.143	0.922	0.671	0.135	0.082

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Inuvik

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
481	1979	5	10	21	146	0	0.46	100.51	0.3	0.053	0.832	0.582	0.181	0.026
482	1979	5	11	5	385	0	0.46	100.57	-6.3	0.147	0.824	0.675	0.136	0.065
483	1979	5	11	6	716	0	0.46	100.61	-10.0	0.226	0.843	0.740	0.119	0.073
484	1979	5	11	7	1097	0	0.46	100.61	-8.1	0.326	0.853	0.782	0.109	0.080
485	1979	5	11	8	1521	0	0.46	100.61	-5.2	0.417	0.859	0.810	0.102	0.028
486	1979	5	15	13	2436	0	0.74	100.74	8.1	0.646	0.866	0.886	0.102	0.044
487	1979	5	15	14	2336	0	0.74	100.66	10.2	0.621	0.867	0.852	0.103	0.041
488	1979	5	18	19	805	0	0.79	99.73	8.6	0.255	0.846	0.746	0.134	0.043
489	1979	5	18	20	474	0	0.79	99.70	7.6	0.157	0.830	0.686	0.146	0.030
490	1979	5	18	21	182	0	0.79	99.70	5.3	0.058	0.809	0.590	0.171	0.058
491	1979	6	1	12	2489	0	1.04	100.61	10.6	0.667	0.870	0.883	0.111	0.136
492	1979	6	1	18	1076	0	1.12	100.57	14.5	0.358	0.857	0.641	0.120	0.080
493	1979	6	3	22	186	0	0.97	100.24	12.4	0.060	0.801	0.590	0.153	0.016
494	1979	6	4	5	817	0	0.86	100.20	4.6	0.222	0.845	0.726	0.146	0.067
495	1979	6	5	5	852	0	0.87	99.94	3.6	0.224	0.845	0.729	0.146	0.061
496	1979	6	5	6	976	0	0.87	99.97	2.6	0.310	0.855	0.771	0.136	0.069
497	1979	6	5	7	1383	0	0.84	100.00	3.2	0.400	0.861	0.801	0.125	0.058
498	1979	6	5	8	1714	0	0.81	100.01	3.6	0.486	0.865	0.823	0.116	0.058
499	1979	6	5	9	2040	0	0.81	100.07	3.2	0.563	0.867	0.836	0.113	0.064
500	1979	6	5	10	2302	0	0.88	100.10	2.6	0.626	0.869	0.849	0.109	0.062
501	1979	6	5	11	2504	0	0.88	100.14	3.9	0.671	0.870	0.855	0.106	0.052
502	1979	6	5	12	2613	0	0.86	100.17	5.7	0.694	0.871	0.858	0.105	0.040
503	1979	6	5	13	2613	0	0.84	100.20	6.7	0.694	0.871	0.858	0.104	0.044
504	1979	6	5	14	2494	0	0.81	100.24	8.1	0.671	0.870	0.855	0.104	0.072
505	1979	6	5	15	2277	0	0.81	100.27	8.3	0.626	0.869	0.850	0.106	0.102
506	1979	6	5	16	1986	0	0.79	100.31	8.1	0.563	0.867	0.840	0.108	0.150
507	1979	6	5	17	1670	0	0.76	100.34	8.8	0.486	0.865	0.825	0.112	0.114
508	1979	6	5	18	1324	0	0.76	100.37	8.4	0.400	0.861	0.804	0.118	0.089
509	1979	6	5	19	914	0	0.74	100.41	8.0	0.310	0.854	0.774	0.128	0.141
510	1979	6	5	20	632	0	0.71	100.47	7.1	0.224	0.845	0.732	0.135	0.089
511	1979	6	5	21	390	0	0.71	100.47	6.6	0.147	0.828	0.674	0.150	0.080
512	1979	6	5	22	217	0	0.69	100.51	4.8	0.064	0.802	0.587	0.168	0.016
513	1979	6	5	23	84	0	0.66	100.57	2.6	0.030	0.666	0.511	0.180	0.022
514	1979	6	6	2	99	0	0.61	100.61	-2.1	0.041	0.670	0.517	0.185	0.013
515	1979	6	6	3	183	0	0.61	100.64	-2.9	0.086	0.804	0.602	0.163	0.080
516	1979	6	6	4	390	0	0.61	100.68	-3.4	0.149	0.828	0.676	0.145	0.060
517	1979	6	6	5	672	0	0.63	100.81	-3.4	0.226	0.846	0.736	0.132	0.084
518	1979	6	6	6	1003	0	0.63	100.85	-3.4	0.312	0.854	0.776	0.121	0.073
519	1979	6	6	7	1378	0	0.66	101.01	-2.4	0.401	0.861	0.806	0.114	0.068
520	1979	6	6	8	1744	0	0.66	101.05	-1.1	0.487	0.865	0.830	0.108	0.051
521	1979	6	8	3	203	0	0.91	100.71	7.0	0.069	0.806	0.606	0.178	0.040
522	1979	6	8	4	385	0	0.89	100.76	6.6	0.152	0.830	0.680	0.158	0.066
523	1979	6	8	5	657	0	0.86	100.81	6.1	0.229	0.845	0.737	0.143	0.076
524	1979	6	8	6	976	0	0.86	100.86	5.1	0.315	0.855	0.776	0.132	0.061
525	1979	6	8	7	1353	0	0.86	100.95	5.1	0.404	0.861	0.806	0.123	0.062
526	1979	6	8	8	1704	0	0.85	101.01	6.3	0.490	0.866	0.831	0.117	0.090
527	1979	6	8	9	2035	0	0.89	101.05	6.0	0.567	0.867	0.846	0.112	0.066
528	1979	6	8	10	2317	0	0.86	101.08	8.1	0.630	0.869	0.857	0.106	0.070
529	1979	6	8	11	2509	0	0.86	101.11	10.4	0.676	0.870	0.863	0.106	0.075
530	1979	6	8	12	2606	0	0.86	101.15	12.3	0.696	0.871	0.867	0.105	0.077
531	1979	6	8	13	2616	0	0.86	101.18	13.7	0.698	0.871	0.867	0.105	0.085
532	1979	6	8	14	2514	0	0.86	101.21	13.9	0.676	0.870	0.864	0.106	0.071
533	1979	6	8	15	2317	0	0.86	101.18	14.9	0.630	0.869	0.857	0.106	0.076
534	1979	6	8	16	2030	0	0.88	101.21	15.5	0.567	0.867	0.847	0.112	0.065
535	1979	6	8	17	1704	0	0.91	101.18	15.5	0.490	0.865	0.832	0.117	0.090
536	1979	6	8	18	1344	0	0.94	101.18	15.9	0.404	0.861	0.810	0.125	0.068
537	1979	6	8	19	934	0	0.97	101.18	15.7	0.315	0.855	0.781	0.134	0.120
538	1979	6	8	20	632	0	0.99	101.18	16.2	0.229	0.845	0.739	0.146	0.095
539	1979	6	8	21	385	0	1.02	101.15	16.1	0.152	0.830	0.682	0.162	0.062
540	1979	6	8	22	186	0	1.04	101.18	15.6	0.069	0.806	0.606	0.163	0.052

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
541	1979	6	8	23	55	0	1.07	101.21	14.5	0.045	0.073	0.535	0.306	0.025
542	1979	6	9	3	164	0	1.19	101.28	7.1	0.081	0.008	0.611	0.169	0.079
543	1979	6	15	7	1383	0	0.87	100.27	11.3	0.412	0.061	0.607	0.125	0.075
544	1979	6	15	8	1734	0	0.87	100.31	12.1	0.496	0.065	0.627	0.118	0.080
545	1979	6	15	9	2055	0	0.88	100.27	13.2	0.575	0.066	0.642	0.115	0.078
546	1979	6	15	10	2322	0	0.98	100.20	15.1	0.637	0.068	0.651	0.111	0.078
547	1979	6	15	11	2509	0	1.02	100.17	17.1	0.682	0.070	0.657	0.110	0.077
548	1979	6	15	12	2628	0	1.02	100.14	18.7	0.705	0.071	0.660	0.109	0.081
549	1979	6	15	13	2623	0	1.04	100.07	20.7	0.705	0.071	0.659	0.108	0.083
550	1979	6	15	14	2524	0	1.04	100.04	20.9	0.682	0.070	0.655	0.110	0.085
551	1979	6	15	15	2065	0	1.07	99.94	22.1	0.575	0.066	0.630	0.116	0.080
552	1979	7	13	5	609	0	1.52	101.55	4.6	0.303	0.056	0.778	0.154	0.085
553	1979	7	13	19	694	0	1.75	101.42	21.4	0.303	0.055	0.777	0.158	0.083
554	1979	7	13	20	566	0	1.75	101.38	21.0	0.216	0.046	0.732	0.171	0.080
555	1979	7	13	21	305	0	1.76	101.35	21.4	0.128	0.030	0.670	0.189	0.082
556	1979	7	13	22	133	0	1.78	101.32	20.8	0.075	0.003	0.589	0.211	0.081
557	1979	7	14	3	126	0	1.80	101.28	9.5	0.073	0.001	0.582	0.214	0.080
558	1979	7	14	4	311	0	1.85	101.28	9.5	0.136	0.030	0.667	0.192	0.088
559	1979	7	14	5	568	0	1.90	101.28	12.8	0.214	0.046	0.730	0.175	0.080
560	1979	7	14	6	864	0	1.96	101.25	14.2	0.300	0.056	0.775	0.163	0.087
561	1979	7	14	7	1248	0	2.01	101.21	14.8	0.380	0.062	0.807	0.154	0.080
562	1979	7	14	8	1578	0	2.06	101.21	16.3	0.477	0.066	0.828	0.147	0.086
563	1979	7	14	9	1862	0	2.11	101.18	17.6	0.554	0.069	0.844	0.142	0.111
564	1979	7	15	9	1857	0	1.78	101.18	16.2	0.552	0.068	0.844	0.138	0.149
565	1979	7	15	10	2118	0	1.76	101.15	17.8	0.616	0.070	0.855	0.133	0.158
566	1979	7	15	11	2282	0	1.76	101.15	19.5	0.660	0.071	0.862	0.130	0.160
567	1979	7	15	12	2396	0	1.76	101.15	21.1	0.684	0.072	0.865	0.128	0.178
568	1979	7	15	13	2371	0	1.76	101.11	22.2	0.684	0.072	0.864	0.128	0.211
569	1979	7	21	14	2223	0	2.18	100.14	21.4	0.616	0.070	0.848	0.130	0.021
570	1979	8	13	11	1951	0	2.21	100.14	19.4	0.569	0.071	0.840	0.144	0.103
571	1979	8	13	12	2050	0	2.34	100.14	21.4	0.593	0.071	0.844	0.143	0.104
572	1979	8	13	13	2050	0	2.36	100.07	23.8	0.593	0.071	0.843	0.143	0.102
573	1979	8	13	14	1951	0	2.38	100.07	25.6	0.566	0.071	0.839	0.145	0.100
574	1979	8	13	15	1756	0	2.41	100.00	27.0	0.523	0.069	0.830	0.148	0.099
575	1979	8	14	16	1477	0	2.57	99.77	26.7	0.452	0.067	0.813	0.156	0.066
576	1979	8	15	5	176	0	2.26	99.63	10.4	0.092	0.018	0.606	0.213	0.082
577	1979	8	15	7	790	0	2.18	99.57	17.0	0.276	0.057	0.784	0.169	0.088
578	1979	8	15	8	1151	0	2.16	99.57	18.0	0.387	0.063	0.788	0.156	0.081
579	1979	8	15	9	1472	0	2.11	99.53	19.6	0.448	0.067	0.812	0.149	0.087
580	1979	8	15	10	1749	0	2.06	99.53	21.3	0.514	0.069	0.825	0.143	0.082
581	1979	8	15	11	1936	0	2.03	99.53	22.9	0.561	0.070	0.834	0.139	0.090
582	1979	8	15	12	2040	0	1.96	99.50	24.5	0.585	0.071	0.836	0.137	0.090
583	1979	8	15	13	2050	0	1.96	99.46	25.6	0.585	0.071	0.837	0.136	0.090
584	1979	8	15	14	1951	0	1.90	99.43	26.0	0.561	0.070	0.833	0.137	0.090
585	1979	8	15	15	1730	0	1.88	99.43	27.1	0.514	0.069	0.824	0.139	0.101
586	1979	8	15	16	1477	0	1.93	99.40	27.7	0.448	0.067	0.809	0.145	0.088
587	1979	8	15	17	1131	0	2.01	99.36	28.2	0.387	0.063	0.787	0.154	0.104
588	1979	8	15	18	761	0	2.06	99.33	28.5	0.276	0.057	0.752	0.169	0.118
589	1979	8	15	19	435	0	2.13	99.33	28.2	0.183	0.045	0.696	0.184	0.101
590	1979	8	19	19	375	0	1.88	100.57	19.8	0.163	0.040	0.686	0.184	0.096
591	1979	8	19	20	123	0	1.86	100.57	17.8	0.072	0.006	0.577	0.218	0.084
592	1980	2	8	14	251	1	0.28	100.41	-10.9	0.065	0.082	0.589	0.134	0.029
593	1980	2	14	15	188	1	0.60	102.28	-10.0	0.072	0.082	0.585	0.176	0.023
594	1980	3	1	10	537	1	0.13	103.03	-26.1	0.163	0.023	0.702	0.094	0.066
595	1980	3	1	11	774	1	0.13	103.03	-30.1	0.211	0.034	0.739	0.087	0.046
596	1980	3	1	12	894	1	0.13	103.07	-32.9	0.236	0.036	0.764	0.084	0.073
597	1980	3	1	13	889	1	0.13	103.10	-32.1	0.236	0.036	0.764	0.084	0.069
598	1980	3	1	14	753	1	0.13	103.13	-30.1	0.211	0.034	0.739	0.087	0.082
599	1980	3	3	14	858	1	0.18	102.43	-24.3	0.224	0.036	0.743	0.084	0.012
600	1980	3	8	8	181	1	0.15	100.47	-27.8	0.063	0.078	0.562	0.123	0.028

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Inuvik

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
801	1980	3	9	9	487	0	0.15	100.41	-25.0	0.147	0.919	0.672	0.100	0.043
802	1980	3	9	10	780	0	0.13	100.37	-26.4	0.216	0.936	0.728	0.085	0.054
803	1980	3	9	11	974	0	0.13	100.31	-26.4	0.263	0.943	0.753	0.080	0.053
804	1980	3	9	12	1085	0	0.13	100.27	-25.3	0.288	0.946	0.763	0.076	0.051
805	1980	3	9	13	1088	0	0.13	100.27	-23.7	0.286	0.946	0.763	0.076	0.058
806	1980	3	9	14	974	0	0.13	100.27	-22.8	0.253	0.943	0.752	0.080	0.053
807	1980	3	9	15	786	0	0.13	100.27	-21.1	0.215	0.936	0.728	0.085	0.053
808	1980	3	9	16	487	0	0.13	100.24	-21.4	0.147	0.919	0.672	0.094	0.044
809	1980	3	20	10	1040	0	0.23	101.18	-18.8	0.280	0.946	0.768	0.083	0.077
810	1980	3	20	11	1278	0	0.20	101.11	-17.7	0.334	0.951	0.787	0.088	0.087
811	1980	3	20	12	1411	0	0.20	101.08	-18.9	0.380	0.953	0.789	0.084	0.048
812	1980	4	3	13	1778	0	0.35	101.88	-20.2	0.448	0.954	0.828	0.094	0.042
813	1980	4	4	17	789	0	0.16	102.33	-19.8	0.228	0.938	0.745	0.093	0.075
814	1980	4	5	13	1602	0	0.20	101.38	-18.4	0.454	0.958	0.828	0.074	0.118
815	1980	4	5	14	1788	0	0.28	102.08	-23.7	0.451	0.958	0.828	0.087	0.048
816	1980	4	6	15	1577	0	0.26	102.06	-23.5	0.403	0.956	0.818	0.090	0.058
817	1980	4	6	16	1281	0	0.24	102.13	-23.3	0.335	0.951	0.794	0.096	0.063
818	1980	4	6	17	884	0	0.26	102.18	-22.5	0.253	0.941	0.758	0.103	0.068
819	1980	4	6	18	502	0	0.36	102.16	-22.4	0.160	0.923	0.694	0.117	0.057
820	1980	4	14	9	1390	0	0.51	100.51	-17.5	0.370	0.954	0.795	0.108	0.060
821	1980	4	14	10	1873	0	0.48	100.47	-17.1	0.437	0.958	0.814	0.102	0.058
822	1980	4	14	11	1898	0	0.48	100.47	-14.8	0.485	0.961	0.828	0.098	0.057
823	1980	4	14	12	2010	0	0.42	100.44	-14.0	0.508	0.962	0.831	0.095	0.047
824	1980	5	1	19	587	0	0.86	100.37	-6.5	0.181	0.926	0.710	0.130	0.065
825	1980	5	14	5	485	0	1.17	100.44	1.3	0.160	0.927	0.685	0.157	0.052
826	1980	5	14	6	788	0	1.14	100.41	1.4	0.248	0.944	0.745	0.150	0.070
827	1980	5	14	7	1184	0	1.14	100.37	1.7	0.340	0.954	0.784	0.138	0.078
828	1980	5	14	8	1532	0	1.12	100.36	2.8	0.428	0.960	0.811	0.128	0.107
829	1980	5	14	9	1838	0	1.12	100.36	3.1	0.507	0.963	0.825	0.123	0.185
830	1980	5	14	10	2104	0	1.13	100.34	3.5	0.572	0.965	0.842	0.118	0.228
831	1980	5	14	11	2329	0	1.09	100.31	4.4	0.618	0.967	0.848	0.116	0.203
832	1980	5	14	12	2473	0	1.08	100.34	4.8	0.643	0.968	0.853	0.115	0.130
833	1980	5	14	13	2487	0	1.07	100.31	3.4	0.642	0.968	0.852	0.114	0.061
834	1980	5	14	14	2441	0	1.07	100.31	3.8	0.618	0.967	0.848	0.115	-0.012
835	1980	5	18	20	384	0	0.76	101.01	3.7	0.167	0.930	0.695	0.148	0.237
836	1980	5	18	21	183	0	0.78	101.01	3.8	0.088	0.884	0.594	0.171	0.143
837	1980	5	25	14	2611	0	0.94	101.52	10.2	0.640	0.968	0.853	0.110	0.084
838	1980	5	25	15	2188	0	0.94	101.53	10.8	0.594	0.966	0.856	0.112	0.100
839	1980	5	25	16	1874	0	0.94	101.52	11.1	0.540	0.964	0.845	0.116	0.143
840	1980	5	25	17	1614	0	0.94	101.48	11.9	0.482	0.961	0.828	0.121	0.060
841	1980	5	25	18	1207	0	0.94	101.48	12.2	0.378	0.956	0.804	0.126	0.063
842	1980	5	25	19	800	0	0.94	101.48	12.9	0.285	0.944	0.768	0.137	0.058
843	1980	5	27	3	112	0	0.74	101.11	-0.1	0.062	0.880	0.582	0.183	0.058
844	1980	5	27	4	208	0	0.74	101.11	-0.5	0.128	0.918	0.655	0.166	0.066
845	1980	5	27	5	553	0	0.74	101.18	-0.6	0.203	0.937	0.723	0.141	0.078
846	1980	5	27	6	880	0	0.74	101.18	-0.6	0.286	0.948	0.770	0.128	0.090
847	1980	5	27	7	1207	0	0.74	101.21	0.3	0.380	0.957	0.804	0.120	0.061
848	1980	5	27	8	1544	0	0.74	101.18	1.4	0.467	0.961	0.827	0.113	0.070
849	1980	5	27	9	1982	0	0.74	101.21	3.1	0.548	0.965	0.843	0.108	0.058
850	1980	5	27	10	2298	0	0.74	101.21	4.5	0.609	0.967	0.854	0.104	0.020
851	1980	5	27	11	2477	0	0.74	101.28	5.3	0.654	0.968	0.861	0.103	0.034
852	1980	5	27	12	2580	0	0.74	101.21	6.0	0.677	0.968	0.864	0.101	0.020
853	1980	5	27	13	2594	0	0.74	101.21	8.3	0.677	0.968	0.864	0.101	0.014
854	1980	5	27	14	2492	0	0.74	101.21	10.1	0.654	0.968	0.861	0.102	0.018
855	1980	5	27	15	2294	0	0.78	101.28	11.2	0.609	0.967	0.855	0.105	0.018
856	1980	5	27	16	2012	0	0.74	101.21	12.3	0.545	0.965	0.843	0.107	0.028
857	1980	5	27	19	878	0	0.88	101.32	7.8	0.280	0.948	0.771	0.134	0.104
858	1980	5	27	20	562	0	0.88	101.32	5.6	0.203	0.937	0.724	0.137	0.063
859	1980	5	27	21	288	0	0.83	101.32	4.1	0.128	0.918	0.658	0.152	0.058
860	1980	5	27	22	128	0	0.61	101.32	3.2	0.062	0.880	0.582	0.174	0.028

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
661	1980	5	25	3	128	0	0.53	101.83	-2.1	0.085	0.083	0.861	0.167	0.046
662	1980	5	26	4	300	0	0.51	101.86	-3.6	0.128	0.017	0.860	0.143	0.073
663	1980	5	26	5	592	0	0.51	101.80	-4.6	0.206	0.027	0.728	0.126	0.073
664	1980	5	26	6	918	0	0.51	101.76	-4.0	0.283	0.040	0.775	0.116	0.066
665	1980	5	26	7	1307	0	0.46	101.76	-4.6	0.383	0.057	0.806	0.106	0.076
666	1980	5	26	8	1721	0	0.46	101.78	-4.4	0.470	0.051	0.832	0.100	0.030
667	1980	5	26	9	2086	0	0.46	101.83	-3.4	0.646	0.066	0.846	0.086	0.036
668	1980	5	26	10	2451	0	0.46	101.85	-1.7	0.611	0.067	0.850	0.082	-0.077
669	1980	5	26	11	2643	0	0.46	101.86	-0.5	0.685	0.066	0.866	0.080	0.023
670	1980	5	26	12	2806	0	0.46	101.86	0.3	0.670	0.066	0.870	0.066	-0.001
671	1980	5	26	13	2858	0	0.46	101.85	1.4	0.679	0.066	0.870	0.086	0.010
672	1980	5	26	14	2654	0	0.46	101.86	3.0	0.666	0.066	0.866	0.085	0.012
673	1980	5	26	21	327	0	0.43	101.72	3.7	0.124	0.017	0.851	0.137	0.086
674	1980	5	29	3	133	0	0.41	101.80	-1.9	0.068	0.004	0.878	0.155	0.066
675	1980	5	29	4	308	0	0.41	101.76	-2.6	0.131	0.016	0.804	0.135	0.068
676	1980	5	29	5	803	0	0.43	101.72	-2.5	0.200	0.036	0.720	0.122	0.076
677	1980	5	29	6	908	0	0.43	101.72	-1.9	0.286	0.040	0.776	0.111	0.111
678	1980	5	29	7	1326	0	0.46	101.80	-0.4	0.365	0.057	0.808	0.104	0.105
679	1980	5	29	8	1655	0	0.46	101.80	0.5	0.472	0.062	0.831	0.086	0.110
680	1980	5	29	9	2002	0	0.46	101.80	2.5	0.560	0.065	0.847	0.085	0.060
681	1980	5	29	10	2366	0	0.46	101.80	2.6	0.613	0.067	0.856	0.082	0.061
682	1980	6	10	13	2865	0	1.02	101.20	14.8	0.700	0.071	0.866	0.110	0.087
683	1980	6	10	14	2466	0	1.02	101.21	15.0	0.677	0.070	0.864	0.111	0.087
684	1980	6	10	15	2296	0	1.02	101.10	16.1	0.633	0.060	0.857	0.113	0.066
685	1980	6	10	16	2027	0	0.87	101.00	16.6	0.570	0.067	0.847	0.114	0.100
686	1980	6	15	18	878	0	0.94	101.46	17.5	0.323	0.055	0.786	0.133	0.120
687	1980	6	15	20	583	0	0.98	101.46	17.8	0.237	0.046	0.746	0.146	0.105
688	1980	6	15	21	386	0	1.02	101.42	16.5	0.161	0.033	0.861	0.181	0.066
689	1980	6	15	22	208	0	1.04	101.36	16.8	0.096	0.010	0.822	0.170	0.057
690	1980	6	15	23	110	0	1.06	101.36	16.0	0.054	0.001	0.846	0.203	0.030
691	1980	6	20	3	215	0	0.98	100.20	6.3	0.100	0.012	0.820	0.176	0.056
692	1980	6	20	4	412	0	1.02	100.17	8.5	0.163	0.033	0.867	0.160	0.070
693	1980	6	20	5	662	0	1.04	100.14	10.6	0.240	0.047	0.730	0.146	0.101
694	1980	6	20	6	1006	0	1.07	100.10	12.5	0.325	0.056	0.777	0.138	0.090
695	1980	6	20	7	1320	0	1.08	100.04	14.8	0.414	0.061	0.806	0.128	0.122
696	1980	6	26	6	981	0	1.70	100.37	18.7	0.335	0.056	0.778	0.154	0.106
697	1980	6	26	8	1034	0	1.72	100.41	19.0	0.489	0.065	0.826	0.138	0.141
698	1980	6	26	9	1063	0	1.78	100.37	20.2	0.576	0.066	0.843	0.134	0.126
699	1980	6	26	10	2197	0	1.78	100.37	21.6	0.636	0.068	0.852	0.130	0.107
700	1980	6	26	11	2182	0	1.80	100.37	22.1	0.682	0.070	0.858	0.128	0.061
701	1980	6	26	12	2770	0	1.80	100.37	23.6	0.705	0.071	0.861	0.127	-0.172
702	1980	6	26	23	-85	0	1.80	100.34	22.1	0.055	0.483	0.840	0.215	0.044
703	1980	6	27	8	1654	0	1.82	100.64	14.6	0.486	0.065	0.830	0.134	0.120
704	1980	6	27	9	1877	0	1.82	100.68	16.4	0.575	0.064	0.845	0.128	0.127
705	1980	6	27	10	2230	0	1.82	100.71	17.8	0.636	0.069	0.855	0.125	0.137
706	1980	6	27	11	2426	0	1.85	100.71	20.1	0.682	0.070	0.861	0.124	0.133
707	1980	6	27	12	2625	0	1.85	100.74	21.0	0.705	0.071	0.864	0.132	0.132
708	1980	6	27	13	2630	0	1.87	100.78	21.6	0.705	0.071	0.866	0.123	0.124
709	1980	6	27	14	2426	0	1.87	100.76	22.5	0.683	0.070	0.862	0.124	0.133
710	1980	6	27	15	2222	0	1.80	100.81	23.7	0.636	0.069	0.856	0.127	0.151
711	1980	6	27	16	1843	0	1.85	100.81	24.6	0.576	0.066	0.846	0.128	0.160
712	1980	6	28	4	384	0	1.27	101.11	10.0	0.161	0.032	0.800	0.170	0.104
713	1980	6	28	5	626	0	1.24	101.15	8.8	0.236	0.046	0.744	0.154	0.133
714	1980	6	28	6	886	0	1.22	101.15	8.9	0.324	0.055	0.784	0.142	0.117
715	1980	6	28	7	1300	0	1.19	101.18	10.2	0.413	0.061	0.813	0.132	0.144
716	1980	6	28	8	1650	0	1.18	101.21	11.2	0.486	0.065	0.834	0.128	0.148
717	1980	6	28	9	1867	0	1.17	101.28	11.9	0.575	0.066	0.840	0.121	0.145
718	1980	7	16	16	1663	0	1.07	101.01	12.6	0.546	0.066	0.843	0.118	0.135
719	1980	7	16	17	1574	0	1.04	101.01	13.1	0.486	0.066	0.826	0.123	0.113
720	1980	7	20	20	903	0	0.74	101.26	10.4	0.186	0.044	0.720	0.141	0.116

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  1     2   3  4  5    6  7   8      9      10     11     12     13     14     15
721   1980  7 20 21   288 0 0.71  101.28    9.8  0.130  0.824  0.848  0.159  0.078
722   1980  7 20 22   120 0 0.71  101.28    8.7  0.058  0.889  0.851  0.162  0.028
723   1980  7 21  3   108 0 0.88  101.28    2.8  0.082  0.808  0.844  0.183  0.037
724   1980  7 21  4   384 0 0.88  101.28    1.3  0.117  0.823  0.648  0.158  0.084
725   1980  7 21  5   818 0 0.88  101.32    1.1  0.188  0.843  0.718  0.140  0.088
726   1980  7 21  8   852 0 0.71  101.32    1.1  0.282  0.884  0.787  0.128  0.088
727   1980  8  9 18   821 0 1.48  100.91   21.8  0.317  0.859  0.778  0.168  0.123
728   1980  8  9 19   558 0 1.47  100.84   21.7  0.224  0.851  0.734  0.182  0.132
729   1980  8  9 20   288 0 1.47  100.61   21.7  0.135  0.833  0.684  0.181  0.088
730   1980  8 10 18   488 0 2.03  101.55   18.8  0.207  0.848  0.727  0.178  0.128
731   1980  8 10 20   229 0 2.03  101.53   18.4  0.117  0.827  0.647  0.201  0.083
732   1980  8 11 14  1048 0 2.24  101.01   22.4  0.578  0.871  0.848  0.142  0.157
733   1980  8 11 15  1768 0 2.28  100.98   23.5  0.531  0.888  0.828  0.148  0.138
734   1980  8 24  8   971 0 1.17  101.42    8.8  0.322  0.880  0.785  0.141  0.125
735   1980  8 24 11  1788 0 1.32  101.38   13.0  0.518  0.889  0.838  0.128  0.158
736   1980  8 24 12  1858 0 1.38  101.32   15.0  0.543  0.870  0.844  0.128  0.188
737   1980  9  6  7   338 0 0.88  101.08   -0.8  0.168  0.838  0.678  0.140  0.108
738   1980  9  6  8   843 0 0.88  101.01   -0.3  0.238  0.854  0.743  0.131  0.150
739   1980  9  6  9   881 0 0.88  100.88   -0.1  0.221  0.881  0.782  0.121  0.148
740   1980  9  6 10  1388 0 0.88  100.88    1.3  0.388  0.888  0.808  0.118  0.128
741   1980  9  6 11  1624 0 0.88  100.88    3.0  0.437  0.887  0.818  0.111  0.086
742   1980  9  8  6    88 0 0.88  100.20   -3.8  0.043  0.888  0.518  0.184  0.063
743   1980  9  8  7   304 0 0.88  100.17   -4.1  0.128  0.837  0.688  0.160  0.118
744   1980  9  8  8   583 0 0.88  100.20   -4.2  0.232  0.854  0.728  0.142  0.188
745   1980  9 24  9   843 0 0.88  100.81   -9.3  0.210  0.881  0.728  0.136  0.198
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COPIE DE QUALITEE INFERIEURE

Baker Lake

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1978	1	8	12	168	*	0.20	103.41	-28.8	0.055	0.873	0.587	0.135	0.085
2	1978	1	20	12	181	*	0.15	101.07	-30.0	0.081	0.900	0.610	0.114	0.174
3	1978	1	20	13	267	*	0.15	101.07	-30.2	0.081	0.900	0.610	0.114	0.046
4	1978	1	20	14	200	*	0.15	101.07	-29.8	0.063	0.881	0.584	0.123	0.018
5	1978	1	26	11	223	*	0.43	103.07	-24.2	0.067	0.888	0.613	0.153	0.058
6	1978	1	26	12	309	*	0.43	103.17	-22.8	0.115	0.910	0.652	0.144	0.077
7	1978	1	26	13	380	*	0.43	103.17	-22.4	0.115	0.910	0.652	0.144	0.037
8	1978	1	26	14	270	*	0.41	103.17	-22.2	0.067	0.888	0.613	0.150	0.018
9	1978	1	27	12	483	*	0.38	103.44	-22.3	0.118	0.912	0.658	0.138	-0.042
10	1978	1	27	13	484	*	0.38	103.47	-21.8	0.118	0.912	0.658	0.138	-0.037
11	1978	1	27	14	381	*	0.38	103.47	-22.6	0.081	0.888	0.621	0.144	-0.043
12	1978	2	3	15	218	*	0.08	101.92	-37.1	0.085	0.877	0.570	0.102	0.013
13	1978	2	3	15	245	*	0.05	102.58	-40.8	0.070	0.860	0.583	0.088	0.011
14	1978	2	7	12	578	*	0.53	103.27	-15.7	0.172	0.926	0.711	0.127	0.026
15	1978	2	7	13	595	*	0.51	103.27	-15.8	0.172	0.926	0.711	0.138	0.024
16	1978	2	7	14	496	*	0.51	103.30	-16.2	0.144	0.917	0.688	0.142	0.010
17	1978	2	7	15	264	*	0.51	103.30	-18.2	0.090	0.893	0.618	0.157	0.009
18	1978	2	8	10	281	*	0.38	102.97	-21.8	0.100	0.899	0.632	0.143	0.049
19	1978	2	8	11	486	*	0.38	102.97	-20.1	0.155	0.921	0.694	0.128	0.051
20	1978	2	8	12	608	*	0.38	102.97	-19.8	0.183	0.926	0.718	0.123	0.058
21	1978	2	8	13	605	*	0.38	102.93	-19.1	0.183	0.926	0.718	0.123	0.061
22	1978	2	8	14	463	*	0.41	102.90	-18.8	0.155	0.921	0.694	0.131	0.052
23	1978	2	8	15	314	*	0.41	102.93	-18.9	0.100	0.899	0.632	0.145	0.020
24	1978	2	13	9	129	*	0.46	103.86	-23.7	0.044	0.859	0.535	0.175	0.019
25	1978	2	13	10	384	*	0.46	103.86	-23.8	0.122	0.909	0.664	0.144	0.047
26	1978	2	13	11	589	*	0.46	103.91	-23.8	0.177	0.927	0.719	0.132	0.068
27	1978	2	13	12	681	*	0.46	104.01	-23.4	0.208	0.933	0.740	0.127	0.085
28	1978	2	13	13	704	*	0.46	103.98	-23.3	0.208	0.933	0.740	0.127	0.084
29	1978	2	13	14	582	*	0.46	103.98	-22.7	0.177	0.926	0.719	0.132	0.093
30	1978	2	13	15	367	*	0.46	104.01	-22.3	0.122	0.909	0.665	0.144	0.053
31	1978	2	13	16	118	*	0.46	104.08	-23.3	0.044	0.859	0.536	0.175	0.019
32	1978	2	16	9	162	*	0.41	102.19	-23.3	0.061	0.874	0.564	0.160	0.012
33	1978	2	16	10	420	*	0.41	102.18	-24.2	0.138	0.916	0.675	0.128	0.049
34	1978	2	16	11	645	*	0.41	102.13	-21.9	0.194	0.931	0.732	0.123	0.063
35	1978	2	16	12	761	*	0.41	102.08	-22.1	0.223	0.937	0.741	0.119	0.070
36	1978	2	16	13	754	*	0.41	102.08	-20.8	0.223	0.937	0.741	0.119	0.077
37	1978	2	16	14	628	*	0.41	102.09	-19.7	0.194	0.931	0.722	0.123	0.078
38	1978	2	16	15	403	*	0.41	102.05	-20.3	0.138	0.916	0.674	0.134	0.074
39	1978	2	16	16	158	*	0.41	102.03	-20.9	0.061	0.874	0.563	0.160	0.032
40	1978	2	17	16	188	*	0.41	101.21	-24.6	0.067	0.878	0.571	0.157	0.044
41	1978	2	28	9	364	*	0.10	102.53	-37.0	0.120	0.908	0.658	0.095	0.047
42	1978	2	28	10	738	*	0.10	102.53	-36.8	0.190	0.932	0.727	0.083	0.042
43	1978	2	28	11	933	*	0.10	102.56	-36.6	0.255	0.942	0.762	0.077	0.088
44	1978	2	28	12	1066	*	0.13	102.53	-35.4	0.284	0.945	0.776	0.080	0.060
45	1978	2	28	13	1025	*	0.13	102.63	-35.8	0.284	0.945	0.778	0.080	0.121
46	1978	2	28	14	866	*	0.13	102.63	-34.9	0.255	0.942	0.762	0.082	0.089
47	1978	2	28	15	675	*	0.13	102.66	-34.8	0.199	0.932	0.726	0.086	0.084
48	1978	2	28	16	367	*	0.13	102.68	-34.5	0.120	0.908	0.658	0.102	0.058
49	1978	3	6	14	1078	*	0.16	101.85	-27.3	0.288	0.947	0.779	0.085	0.119
50	1978	3	7	13	1329	*	0.20	102.19	-30.8	0.340	0.951	0.787	0.067	0.047
51	1978	3	13	8	546	*	0.10	101.21	-35.8	0.207	0.934	0.725	0.061	0.330
52	1978	3	12	10	919	*	0.10	101.21	-30.8	0.285	0.946	0.769	0.073	0.278
53	1978	3	14	9	804	*	0.10	101.88	-36.1	0.218	0.936	0.737	0.080	0.318
54	1978	3	14	10	996	*	0.10	101.66	-35.3	0.280	0.947	0.776	0.073	0.246
55	1978	3	14	11	1365	*	0.10	101.92	-34.3	0.398	0.952	0.800	0.068	0.120
56	1978	3	15	12	1556	*	0.16	101.98	-29.5	0.391	0.955	0.812	0.080	0.087
57	1978	3	15	13	1582	*	0.15	101.92	-28.2	0.391	0.955	0.812	0.076	0.089
58	1978	3	15	14	1297	*	0.15	101.92	-26.9	0.382	0.953	0.802	0.076	0.088
59	1978	3	15	15	1117	*	0.15	101.92	-28.1	0.305	0.948	0.781	0.082	0.113
60	1978	3	15	16	751	*	0.15	101.92	-28.3	0.225	0.937	0.741	0.090	0.114

POOR COPY
COPIE DE QUALITEE INFERIEURE

Baker Lake

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
61	1978	3	20	9	779	*	0.10	100.80	-32.3	0.257	0.842	0.762	0.078	0.274
62	1978	3	20	10	1152	*	0.10	100.80	-32.3	0.337	0.851	0.786	0.083	0.276
63	1978	3	20	11	1591	*	0.10	100.80	-31.4	0.393	0.855	0.805	0.088	0.057
64	1978	3	20	14	1818	*	0.10	100.90	-29.8	0.393	0.855	0.805	0.088	0.032
65	1978	3	20	15	1314	*	0.10	100.93	-29.8	0.337	0.851	0.787	0.083	0.070
66	1978	3	20	16	810	*	0.10	100.97	-29.2	0.257	0.842	0.753	0.078	0.102
67	1978	3	21	11	1585	*	0.10	101.24	-33.3	0.400	0.858	0.810	0.086	0.128
68	1978	3	21	12	1724	*	0.10	101.27	-32.2	0.428	0.857	0.818	0.084	0.088
69	1978	3	21	13	1734	*	0.10	101.27	-32.0	0.428	0.857	0.818	0.084	0.088
70	1978	3	22	15	1177	*	0.15	102.28	-30.4	0.349	0.852	0.800	0.078	0.311
71	1978	3	22	16	851	*	0.15	102.25	-29.8	0.268	0.843	0.767	0.085	0.086
72	1978	3	25	10	1385	*	0.15	103.13	-29.7	0.368	0.853	0.812	0.082	0.158
73	1978	3	25	11	1645	*	0.15	103.13	-28.4	0.424	0.857	0.829	0.078	0.147
74	1978	3	25	12	1807	*	0.15	103.13	-28.4	0.454	0.858	0.837	0.078	0.123
75	1978	3	25	13	1820	*	0.15	103.10	-27.8	0.454	0.858	0.837	0.078	0.105
76	1978	3	25	14	1718	*	0.15	103.07	-28.8	0.424	0.857	0.829	0.078	0.080
77	1978	3	26	13	1893	*	0.20	102.53	-28.1	0.480	0.858	0.834	0.078	0.034
78	1978	3	26	14	1731	*	0.20	102.53	-28.8	0.430	0.857	0.827	0.081	0.081
79	1978	3	26	15	1444	*	0.20	102.53	-24.7	0.374	0.853	0.810	0.084	0.085
80	1978	3	26	16	810	*	0.20	102.53	-24.1	0.284	0.848	0.780	0.090	0.303
81	1978	3	26	17	550	*	0.20	102.53	-24.0	0.188	0.831	0.725	0.102	0.188
82	1978	3	27	9	880	*	0.23	102.48	-30.2	0.300	0.847	0.763	0.083	0.223
83	1978	3	27	10	1422	*	0.23	102.48	-29.1	0.360	0.854	0.812	0.087	0.136
84	1978	3	27	15	1460	*	0.20	102.48	-28.3	0.360	0.854	0.812	0.084	0.088
85	1978	3	27	16	1068	*	0.20	102.48	-26.1	0.300	0.847	0.763	0.090	0.087
86	1978	3	30	8	748	*	0.13	102.53	-31.8	0.220	0.836	0.742	0.088	0.083
87	1978	3	30	9	1161	*	0.13	102.53	-31.5	0.318	0.848	0.780	0.077	0.130
88	1978	3	30	10	1654	*	0.13	102.53	-31.2	0.368	0.855	0.818	0.071	0.004
89	1978	3	30	16	1203	*	0.10	102.46	-28.1	0.318	0.848	0.780	0.071	0.082
90	1978	3	30	17	780	*	0.10	102.39	-28.8	0.220	0.836	0.741	0.080	0.087
91	1978	3	31	13	2023	*	0.25	101.85	-24.3	0.480	0.860	0.837	0.083	0.018
92	1978	3	31	14	1880	*	0.23	101.88	-23.7	0.460	0.859	0.830	0.081	0.033
93	1978	3	31	16	1280	*	0.20	101.85	-23.0	0.324	0.849	0.786	0.087	0.041
94	1978	4	3	17	900	*	0.15	102.48	-27.2	0.244	0.840	0.755	0.088	0.044
95	1978	4	4	9	1222	*	0.15	102.15	-29.5	0.346	0.852	0.795	0.083	0.204
96	1978	4	4	10	1629	*	0.15	102.12	-29.0	0.427	0.857	0.823	0.077	0.186
97	1978	4	4	11	1888	*	0.15	102.08	-28.7	0.484	0.860	0.837	0.074	0.181
98	1978	4	4	12	2062	*	0.15	102.05	-28.3	0.513	0.862	0.843	0.073	0.144
99	1978	4	4	13	2083	*	0.15	102.02	-25.8	0.513	0.862	0.843	0.073	0.086
100	1978	4	4	14	1868	*	0.15	102.02	-26.0	0.484	0.860	0.836	0.074	0.078
101	1978	4	4	15	1595	*	0.15	101.95	-24.8	0.427	0.857	0.822	0.077	0.079
102	1978	4	4	16	1304	*	0.15	101.95	-24.8	0.348	0.852	0.798	0.082	0.101
103	1978	4	4	17	859	*	0.15	101.95	-22.7	0.250	0.841	0.756	0.081	0.100
104	1978	4	5	8	760	*	0.15	101.78	-32.4	0.282	0.843	0.760	0.080	0.308
105	1978	4	5	9	1278	*	0.15	101.81	-31.7	0.358	0.853	0.801	0.082	0.199
106	1978	4	5	10	1838	*	0.15	101.85	-31.0	0.438	0.858	0.824	0.077	0.234
107	1978	4	5	12	2157	*	0.15	101.92	-28.0	0.524	0.862	0.844	0.068	0.080
108	1978	4	5	14	2036	*	0.15	101.92	-27.4	0.495	0.861	0.838	0.070	0.065
109	1978	4	5	15	1740	*	0.15	101.92	-26.8	0.439	0.856	0.825	0.073	0.100
110	1978	4	5	16	1365	*	0.15	101.95	-26.8	0.358	0.853	0.802	0.078	0.088
111	1978	4	5	17	861	*	0.15	101.95	-25.5	0.282	0.843	0.781	0.086	0.136
112	1978	4	7	9	1381	*	0.13	102.28	-32.7	0.365	0.853	0.806	0.073	0.120
113	1978	4	7	10	1782	*	0.13	102.28	-31.2	0.444	0.858	0.825	0.069	0.094
114	1978	4	7	11	2052	*	0.13	102.28	-30.0	0.501	0.861	0.842	0.068	0.087
115	1978	4	7	12	2192	*	0.15	102.28	-28.4	0.530	0.862	0.848	0.068	0.060
116	1978	4	7	13	2202	*	0.15	102.28	-27.2	0.530	0.862	0.848	0.069	0.065
117	1978	4	7	14	2058	*	0.15	102.28	-24.9	0.501	0.861	0.842	0.070	0.078
118	1978	4	7	15	1781	*	0.15	102.28	-24.8	0.444	0.858	0.828	0.073	0.071
119	1978	4	7	16	1383	*	0.15	102.28	-24.8	0.365	0.853	0.806	0.077	0.097
120	1978	4	7	17	813	*	0.15	102.28	-24.8	0.287	0.843	0.786	0.085	0.132

POOR COPY
COPIE DE QUALITEE INFERIEURE

Baker Lake

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
121	1976	4	7	13	448	*	0.15	102.29	-25.1	0.155	0.922	0.694	0.103	0.120
122	1976	4	16	7	884	*	0.15	103.03	-26.1	0.221	0.938	0.745	0.095	0.138
123	1976	4	16	8	1174	*	0.15	103.13	-25.2	0.326	0.950	0.786	0.084	0.141
124	1976	4	16	9	1536	*	0.20	103.17	-24.7	0.424	0.957	0.830	0.081	0.118
125	1976	4	16	10	2023	*	0.20	103.24	-24.7	0.503	0.961	0.849	0.077	0.109
126	1976	4	21	10	2001	*	0.25	99.55	-17.2	0.518	0.952	0.828	0.080	0.155
127	1976	4	22	6	356	*	0.13	100.63	-26.5	0.131	0.914	0.658	0.095	0.090
128	1976	4	22	7	782	*	0.13	100.63	-26.2	0.242	0.940	0.743	0.082	0.132
129	1976	4	22	16	882	*	0.15	100.85	-18.7	0.242	0.940	0.743	0.087	0.054
130	1976	4	23	11	2415	*	0.15	101.48	-21.4	0.583	0.964	0.852	0.070	0.070
131	1976	4	23	12	2520	*	0.20	101.61	-20.2	0.612	0.965	0.858	0.072	0.112
132	1976	4	23	13	2589	*	0.20	101.70	-18.9	0.612	0.965	0.856	0.071	-0.028
133	1976	4	23	14	2468	*	0.20	101.75	-18.3	0.583	0.964	0.854	0.073	-0.024
134	1976	4	23	15	2240	*	0.23	101.85	-17.7	0.528	0.952	0.845	0.076	-0.068
135	1976	4	23	16	1902	*	0.23	101.95	-17.7	0.449	0.959	0.828	0.082	-0.073
136	1976	4	23	17	1384	*	0.23	102.02	-17.8	0.384	0.952	0.800	0.088	0.020
137	1976	4	24	6	442	*	0.20	102.83	-28.3	0.141	0.917	0.680	0.111	0.048
138	1976	4	24	7	849	*	0.20	102.90	-25.6	0.262	0.941	0.782	0.095	0.106
139	1976	4	24	8	1276	*	0.20	102.90	-25.1	0.384	0.952	0.806	0.085	0.176
140	1976	4	24	12	2587	*	0.23	102.97	-20.7	0.616	0.965	0.868	0.075	0.070
141	1976	4	24	13	2567	*	0.23	102.97	-19.3	0.616	0.965	0.869	0.075	0.070
142	1976	4	24	14	2468	*	0.23	102.97	-18.1	0.587	0.964	0.864	0.078	0.012
143	1976	4	24	15	2214	*	0.23	103.00	-17.7	0.532	0.952	0.854	0.078	0.007
144	1976	4	24	16	1846	*	0.23	103.00	-16.3	0.454	0.959	0.836	0.082	0.016
145	1976	4	25	16	1883	*	0.41	102.25	-13.0	0.459	0.959	0.832	0.097	-0.047
146	1976	4	26	7	732	*	0.30	102.80	-22.4	0.262	0.943	0.767	0.105	0.316
147	1976	4	26	8	1358	*	0.30	102.80	-22.1	0.384	0.953	0.810	0.095	0.104
148	1976	4	26	9	1858	*	0.30	102.80	-20.7	0.484	0.958	0.837	0.089	0.030
149	1976	4	26	10	2157	*	0.30	102.80	-20.6	0.541	0.963	0.864	0.085	0.128
150	1976	4	26	11	2443	*	0.30	102.76	-19.2	0.597	0.965	0.864	0.082	0.081
151	1976	4	26	12	2602	*	0.30	102.60	-17.3	0.625	0.965	0.869	0.081	0.033
152	1976	4	26	13	2606	*	0.30	102.60	-15.2	0.625	0.965	0.868	0.081	0.028
153	1976	4	27	7	849	*	0.30	102.88	-23.0	0.287	0.943	0.789	0.105	0.181
154	1976	4	27	8	1371	*	0.30	102.93	-22.8	0.373	0.954	0.813	0.095	0.114
155	1976	4	27	9	1836	*	0.30	102.97	-22.1	0.466	0.958	0.840	0.089	0.085
156	1976	4	27	10	2224	*	0.30	103.03	-21.3	0.548	0.963	0.857	0.085	0.051
157	1976	4	27	11	2494	*	0.30	103.07	-20.3	0.601	0.965	0.867	0.082	0.026
158	1976	4	27	12	2653	*	0.30	103.10	-16.7	0.629	0.965	0.872	0.081	-0.021
159	1976	4	27	13	2666	*	0.25	103.17	-17.7	0.629	0.965	0.872	0.079	-0.030
160	1976	4	27	14	2539	*	0.26	103.20	-16.4	0.601	0.965	0.866	0.080	-0.034
161	1976	4	27	15	2297	*	0.28	103.24	-19.1	0.548	0.963	0.858	0.082	-0.044
162	1976	4	27	16	1931	*	0.26	103.27	-15.6	0.466	0.959	0.842	0.086	-0.023
163	1976	4	27	17	1467	*	0.26	103.34	-15.6	0.373	0.953	0.816	0.093	0.016
164	1976	4	27	18	954	*	0.26	103.41	-15.6	0.287	0.943	0.773	0.102	0.045
165	1976	4	27	19	474	*	0.28	103.47	-16.4	0.158	0.921	0.695	0.116	0.087
166	1976	5	3	7	889	*	0.78	102.19	-12.0	0.284	0.948	0.778	0.121	0.082
167	1976	5	3	8	1453	*	0.79	102.15	-11.9	0.400	0.956	0.816	0.121	0.076
168	1976	5	8	9	1872	*	0.25	101.56	-16.1	0.514	0.963	0.840	0.081	0.205
169	1976	5	8	10	2345	*	0.25	101.51	-15.2	0.581	0.965	0.864	0.077	0.196
170	1976	5	8	11	2634	*	0.25	101.51	-14.4	0.645	0.966	0.882	0.075	0.134
171	1976	5	8	12	2777	*	0.25	101.48	-13.7	0.673	0.966	0.885	0.074	0.112
172	1976	5	8	13	2809	*	0.25	101.44	-13.0	0.673	0.966	0.885	0.074	0.041
173	1976	5	8	14	2707	*	0.25	101.41	-12.2	0.645	0.966	0.881	0.075	-0.013
174	1976	5	8	15	2482	*	0.25	101.37	-11.8	0.581	0.966	0.853	0.077	-0.015
175	1976	5	8	16	2108	*	0.25	101.31	-11.6	0.514	0.963	0.838	0.081	-0.008
176	1976	5	8	17	1670	*	0.25	101.24	-11.6	0.420	0.958	0.815	0.088	0.014
177	1976	5	8	18	1184	*	0.25	101.17	-10.2	0.316	0.952	0.781	0.093	0.084
178	1976	5	8	19	617	*	0.25	101.14	-10.9	0.207	0.936	0.726	0.105	0.137
179	1976	5	11	7	1113	*	0.22	100.29	-25.7	0.327	0.953	0.779	0.090	0.173
180	1976	5	14	8	1633	*	0.46	102.02	-13.1	0.442	0.960	0.827	0.101	0.142

POOR COPY
COPIE DE QUALITEE INFERIEURE

Baker Lake

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
181	1978	6	14	9	2087	*	0.45	101.95	-11.7	0.535	0.964	0.847	0.085	0.104
182	1978	6	14	10	2431	*	0.48	101.95	-10.5	0.611	0.967	0.860	0.083	0.118
183	1978	6	16	6	709	*	0.38	102.22	-16.5	0.238	0.942	0.751	0.115	0.172
184	1978	6	16	7	1180	*	0.38	102.28	-15.4	0.348	0.954	0.800	0.103	0.157
185	1978	6	16	8	1669	*	0.38	102.49	-13.9	0.449	0.960	0.832	0.095	0.127
186	1978	6	20	13	2083	*	0.38	102.02	-6.3	0.710	0.969	0.875	0.083	-0.032
187	1978	6	20	14	2085	*	0.38	102.02	-7.7	0.682	0.964	0.871	0.082	-0.064
188	1978	6	20	15	2025	*	0.38	102.02	-7.3	0.629	0.957	0.863	0.084	-0.055
189	1978	6	20	16	2300	*	0.38	101.95	-6.5	0.584	0.965	0.850	0.087	-0.057
190	1978	6	21	5	471	*	0.48	101.95	-14.9	0.153	0.925	0.687	0.137	0.036
191	1978	6	21	6	888	*	0.51	101.98	-14.9	0.265	0.945	0.758	0.122	0.036
192	1978	6	21	7	1265	*	0.48	102.02	-14.2	0.382	0.955	0.803	0.109	0.020
193	1978	6	21	8	1721	*	0.48	102.05	-12.2	0.484	0.961	0.832	0.101	0.152
194	1978	6	21	9	2157	*	0.48	102.05	-12.0	0.557	0.965	0.851	0.096	0.140
195	1978	6	21	10	2481	*	0.48	102.05	-10.6	0.632	0.967	0.864	0.092	0.176
196	1978	6	21	11	2774	*	0.48	102.09	-8.3	0.685	0.968	0.872	0.090	0.103
197	1978	6	21	12	2883	*	0.48	102.09	-6.5	0.712	0.969	0.875	0.089	-0.058
198	1978	6	21	14	2919	*	0.48	102.09	-7.2	0.685	0.968	0.872	0.089	0.011
199	1978	6	21	15	2871	*	0.48	102.09	-6.5	0.632	0.967	0.864	0.091	0.024
200	1978	6	21	16	2285	*	0.48	102.05	-5.9	0.557	0.965	0.851	0.094	-0.028
201	1978	6	26	12	2830	*	0.44	101.68	-2.1	0.728	0.959	0.876	0.104	0.046
202	1978	6	26	13	2852	*	0.59	101.92	-3.0	0.728	0.969	0.876	0.105	-0.018
203	1978	6	26	15	2580	*	0.59	101.95	-1.9	0.648	0.964	0.865	0.109	0.015
204	1978	6	29	4	257	0	0.81	101.92	0.1	0.114	0.917	0.645	0.171	0.082
205	1978	6	29	5	556	0	0.91	101.85	1.1	0.204	0.941	0.727	0.148	0.060
206	1978	6	29	6	932	0	0.91	101.88	2.1	0.304	0.953	0.781	0.135	0.082
207	1978	6	29	7	1358	0	0.81	102.02	3.8	0.408	0.961	0.817	0.125	0.080
208	1978	6	29	8	1777	0	0.91	102.05	5.5	0.509	0.965	0.842	0.117	0.095
209	1978	6	29	9	2210	0	0.84	102.02	7.0	0.599	0.968	0.859	0.113	0.040
210	1978	6	29	20	488	0	1.07	102.02	10.5	0.204	0.941	0.728	0.155	0.136
211	1978	7	1	12	2644	0	1.17	102.02	8.5	0.750	0.973	0.880	0.113	0.025
212	1978	7	1	13	2844	0	1.12	102.05	9.3	0.780	0.973	0.880	0.111	0.033
213	1978	7	1	14	2713	0	1.07	102.05	11.0	0.723	0.972	0.877	0.111	0.060
214	1978	7	1	15	2493	0	1.04	102.05	13.0	0.671	0.971	0.870	0.112	0.080
215	1978	7	1	16	2135	0	0.88	102.05	11.4	0.597	0.970	0.859	0.114	0.117
216	1978	7	1	17	1895	0	0.84	102.05	14.2	0.507	0.967	0.842	0.118	0.180
217	1978	7	1	18	1334	0	0.81	102.05	13.9	0.407	0.963	0.817	0.124	0.111
218	1978	7	2	5	571	0	0.81	102.15	2.3	0.201	0.944	0.727	0.150	0.080
219	1978	7	2	6	973	0	0.81	102.19	3.5	0.302	0.956	0.782	0.135	0.052
220	1978	7	2	7	1408	0	0.81	102.19	3.7	0.408	0.963	0.818	0.125	0.044
221	1978	7	2	8	1786	0	0.81	102.19	5.9	0.506	0.967	0.843	0.117	0.070
222	1978	7	2	10	2483	0	0.84	102.19	7.7	0.570	0.971	0.871	0.109	0.081
223	1978	7	6	10	2421	0	1.17	100.90	8.2	0.684	0.971	0.860	0.116	0.062
224	1978	7	6	11	2847	0	1.17	100.93	10.1	0.718	0.972	0.867	0.113	0.076
225	1978	7	6	12	2744	0	1.17	100.93	12.0	0.743	0.973	0.870	0.112	0.102
226	1978	7	6	13	2738	0	1.14	100.90	12.6	0.743	0.973	0.870	0.111	0.113
227	1978	7	6	14	2837	0	1.16	100.93	14.2	0.718	0.972	0.867	0.112	0.085
228	1978	7	24	10	2236	0	1.19	100.53	11.9	0.632	0.971	0.853	0.118	0.136
229	1978	7	24	13	2840	0	1.27	100.50	14.5	0.713	0.973	0.863	0.116	0.193
230	1978	8	5	16	1780	0	1.30	101.27	15.2	0.619	0.969	0.829	0.127	0.117
231	1978	8	5	17	1365	0	1.32	101.24	15.7	0.425	0.965	0.817	0.135	0.118
232	1978	8	5	18	948	0	1.37	101.24	16.4	0.320	0.950	0.783	0.147	0.126
233	1978	8	5	19	843	0	1.35	101.24	13.3	0.212	0.949	0.728	0.161	0.115
234	1978	8	5	20	185	0	1.35	101.24	13.7	0.108	0.924	0.634	0.187	0.111
235	1978	8	6	8	581	0	1.35	101.17	5.6	0.208	0.948	0.728	0.163	0.065
236	1978	8	6	12	2424	0	1.37	101.00	13.3	0.674	0.973	0.862	0.120	0.131
237	1978	8	7	6	486	0	1.47	100.73	6.0	0.204	0.946	0.721	0.157	0.131
238	1978	8	7	7	929	0	1.42	100.73	6.3	0.312	0.959	0.777	0.149	0.110
239	1978	8	7	8	1359	0	1.40	100.77	6.5	0.417	0.965	0.811	0.138	0.106
240	1978	8	7	9	1742	0	1.37	100.77	9.5	0.611	0.969	0.833	0.130	0.117

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Baker Lake

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
241	1978	8	7	10	2053	0	1.38	100.77	11.4	0.585	0.871	0.845	0.124	0.136
242	1978	8	7	11	2278	0	1.32	100.77	13.1	0.642	0.872	0.856	0.121	0.148
243	1978	8	7	12	2402	0	1.30	100.77	13.7	0.670	0.873	0.860	0.119	0.148
244	1978	8	7	13	2411	0	1.24	100.77	14.8	0.670	0.873	0.860	0.117	0.139
245	1978	9	16	11	1583	0	0.78	100.80	4.9	0.447	0.868	0.820	0.115	0.097
246	1978	9	16	12	1698	0	0.79	100.87	5.8	0.476	0.869	0.827	0.114	0.085
247	1978	9	16	13	1709	0	0.79	100.87	7.2	0.476	0.869	0.827	0.114	0.078
248	1978	9	16	14	1582	0	0.79	100.83	7.8	0.447	0.868	0.819	0.116	0.088
249	1978	9	16	15	1353	0	0.81	100.83	8.3	0.390	0.865	0.804	0.121	0.085
250	1978	9	16	16	1002	0	0.81	100.80	6.9	0.310	0.861	0.776	0.129	0.079
251	1978	9	17	8	948	0	0.81	101.10	1.8	0.304	0.860	0.776	0.134	0.102
252	1978	10	15	11	857	*	0.42	101.71	-12.9	0.288	0.856	0.763	0.114	0.185
253	1978	10	15	12	875	*	0.42	101.88	-12.7	0.297	0.858	0.776	0.111	0.190
254	1978	10	15	14	801	*	0.41	101.85	-11.5	0.268	0.856	0.763	0.112	0.127
255	1978	10	15	15	672	*	0.41	101.85	-11.1	0.212	0.850	0.731	0.120	0.108
256	1978	10	23	15	508	*	0.35	100.87	-21.3	0.164	0.842	0.691	0.113	0.083
257	1978	10	23	16	229	*	0.23	101.00	-21.8	0.085	0.815	0.601	0.126	0.057
258	1978	11	8	15	182	*	0.18	100.80	-24.8	0.078	0.805	0.587	0.123	0.080
259	1978	11	18	13	321	*	0.18	102.53	-21.3	0.112	0.821	0.648	0.114	0.075
260	1978	11	21	11	271	*	0.20	101.21	-24.3	0.072	0.802	0.581	0.129	-0.010
261	1978	11	22	12	248	*	0.15	101.37	-30.7	0.086	0.815	0.618	0.112	0.082
262	1978	11	22	13	246	*	0.15	101.41	-30.3	0.088	0.815	0.619	0.112	0.091
263	1978	11	23	12	284	*	0.15	101.58	-33.9	0.082	0.813	0.615	0.114	0.040
264	1978	11	23	13	278	*	0.13	101.58	-33.6	0.082	0.813	0.615	0.108	0.048
265	1978	11	24	11	182	*	0.13	102.86	-34.4	0.061	0.893	0.585	0.119	0.082
266	1978	11	24	12	245	*	0.13	102.63	-34.0	0.069	0.811	0.614	0.110	0.067
267	1978	11	24	13	231	*	0.13	102.68	-33.8	0.069	0.811	0.614	0.110	0.083
268	1978	11	24	14	182	*	0.13	102.78	-33.7	0.051	0.893	0.567	0.119	0.062
269	1978	12	7	12	118	*	0.46	101.95	-28.1	0.052	0.878	0.548	0.170	0.051
270	1978	12	7	13	118	*	0.46	101.95	-28.6	0.052	0.878	0.545	0.172	0.050
271	1979	1	15	11	126	*	0.10	101.58	-40.5	0.046	0.857	0.521	0.118	0.037
272	1979	1	15	12	204	*	0.10	101.84	-41.3	0.074	0.889	0.585	0.107	0.054
273	1979	1	15	13	220	*	0.10	101.88	-40.1	0.074	0.889	0.585	0.107	0.038
274	1979	1	17	13	248	*	0.18	101.58	-36.7	0.080	0.893	0.596	0.123	0.027
275	1979	1	19	12	188	*	0.26	101.34	-31.2	0.087	0.897	0.606	0.138	0.117
276	1979	1	19	13	217	*	0.26	101.37	-30.8	0.087	0.897	0.606	0.138	0.078
277	1979	1	21	12	320	*	0.20	102.25	-33.3	0.094	0.901	0.621	0.123	0.013
278	1979	1	21	13	301	*	0.20	102.22	-32.8	0.094	0.901	0.620	0.123	0.027
279	1979	1	21	14	201	*	0.20	102.19	-32.4	0.087	0.884	0.575	0.133	0.024
280	1979	1	22	11	185	*	0.20	102.48	-35.7	0.071	0.886	0.583	0.132	-0.042
281	1979	1	22	12	257	*	0.20	102.58	-36.4	0.098	0.903	0.627	0.122	0.083
282	1979	1	22	13	264	*	0.20	102.56	-35.9	0.098	0.903	0.627	0.122	0.075
283	1979	1	29	12	399	*	0.18	101.85	-29.4	0.128	0.916	0.661	0.110	0.057
284	1979	1	29	13	402	*	0.18	101.85	-29.6	0.128	0.916	0.661	0.110	0.056
285	1979	1	29	14	317	*	0.18	101.85	-28.9	0.100	0.904	0.627	0.116	0.032
286	1979	1	29	15	179	*	0.18	101.85	-28.8	0.048	0.857	0.532	0.137	-0.010
287	1979	1	31	11	295	*	0.10	102.36	-35.7	0.109	0.908	0.641	0.098	0.099
288	1979	1	31	12	411	*	0.10	102.32	-36.1	0.137	0.919	0.673	0.092	0.085
289	1979	1	31	14	317	*	0.10	102.29	-38.1	0.108	0.908	0.641	0.098	0.074
290	1979	1	31	15	179	*	0.10	102.29	-35.4	0.055	0.874	0.563	0.114	0.016
291	1979	2	1	12	462	*	0.08	102.49	-38.8	0.142	0.917	0.679	0.084	0.068
292	1979	2	1	14	336	*	0.08	102.53	-38.6	0.114	0.906	0.648	0.089	0.078
293	1979	2	2	12	448	*	0.08	102.73	-41.7	0.147	0.916	0.685	0.083	0.105
294	1979	2	2	13	452	*	0.08	102.73	-41.0	0.147	0.918	0.685	0.083	0.098
295	1979	2	2	14	327	*	0.08	102.73	-39.8	0.119	0.908	0.555	0.088	0.110
296	1979	2	5	12	548	*	0.08	102.63	-44.4	0.162	0.923	0.699	0.081	0.071
297	1979	2	5	13	553	*	0.08	102.63	-43.1	0.162	0.923	0.699	0.081	0.085
298	1979	2	5	14	449	*	0.08	102.63	-42.9	0.134	0.914	0.671	0.085	0.050
299	1979	2	6	11	446	*	0.05	103.44	-45.8	0.150	0.919	0.682	0.073	0.128
300	1979	2	6	12	590	*	0.08	103.13	-44.7	0.183	0.928	0.719	0.078	0.121

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COPIE DE QUALITEE INFERIEURE

Baker Lake

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 1        2   3 4  5   6 7  8      9     10    11    12    13    14    15
301     1979  2  9 13 580 * 0.05 103.13 -43.5 0.183 0.928 0.718 0.078 0.121
302     1979  2  9 14 485 * 0.05 103.07 -43.0 0.155 0.921 0.695 0.082 0.122
303     1979  2  9 15 285 * 0.05 103.07 -42.2 0.100 0.889 0.633 0.082 0.073
304     1979  2 13 11 672 * 0.05 102.80 -47.3 0.177 0.927 0.712 0.089 0.030
305     1979  2 13 12 782 * 0.05 102.80 -45.4 0.205 0.933 0.734 0.086 0.044
306     1979  2 13 13 813 * 0.05 102.73 -44.5 0.205 0.933 0.733 0.086 0.029
307     1979  2 13 14 681 * 0.05 102.73 -43.3 0.177 0.927 0.712 0.089 0.015
308     1979  2 13 15 449 * 0.05 102.73 -42.5 0.122 0.909 0.659 0.077 0.017
309     1979  2 13 16 185 * 0.05 102.73 -42.2 0.044 0.855 0.531 0.094 0.001
310     1979  2 14 11 615 * 0.05 103.10 -41.5 0.183 0.928 0.719 0.088 0.234
311     1979  2 14 12 672 * 0.05 103.17 -41.3 0.211 0.934 0.740 0.085 0.181
312     1979  2 14 13 764 * 0.05 103.17 -39.6 0.211 0.934 0.740 0.085 0.089
313     1979  2 14 14 637 * 0.05 103.24 -38.3 0.183 0.928 0.719 0.088 0.078
314     1979  2 14 15 411 * 0.05 103.24 -38.5 0.128 0.911 0.666 0.078 0.085
315     1979  2 17 12 772 * 0.15 102.29 -33.3 0.228 0.938 0.745 0.090 0.119
316     1979  2 17 13 779 * 0.15 102.25 -32.7 0.229 0.938 0.745 0.089 0.112
317     1979  2 17 14 658 * 0.18 102.25 -32.5 0.200 0.932 0.727 0.097 0.103
318     1979  2 17 15 430 * 0.18 102.26 -32.4 0.145 0.918 0.681 0.106 0.081
319     1979  2 17 16 166 * 0.20 102.25 -32.5 0.057 0.878 0.575 0.133 0.054
320     1979  2 18 11 725 * 0.15 101.95 -35.9 0.206 0.934 0.729 0.092 0.057
321     1979  2 19 11 710 * 0.23 101.31 -34.0 0.212 0.935 0.729 0.103 0.080
322     1979  2 19 12 886 * 0.23 101.27 -33.3 0.241 0.940 0.746 0.099 0.036
323     1979  2 20 14 575 * 0.08 101.58 -37.7 0.218 0.935 0.735 0.073 0.201
324     1979  2 20 15 210 * 0.08 101.81 -37.9 0.084 0.850 0.602 0.085 0.068
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COPIE DE QUALITEE INFERIEURE

Frobisher Bay

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1978	1	8	13	202	*	0.10	101.73	-34.6	0.055	0.862	0.561	0.110	0.024
2	1978	2	3	10	218	*	0.08	103.08	-35.3	0.077	0.885	0.589	0.096	0.064
3	1978	2	3	11	425	*	0.08	103.11	-35.8	0.133	0.913	0.673	0.085	0.058
4	1978	2	3	12	532	*	0.08	103.11	-34.3	0.181	0.923	0.701	0.081	0.080
5	1978	2	3	13	526	*	0.08	103.15	-35.1	0.181	0.923	0.701	0.081	0.088
6	1978	2	3	14	383	*	0.08	103.15	-34.8	0.133	0.913	0.673	0.085	0.109
7	1978	2	3	15	202	*	0.08	103.18	-34.7	0.077	0.885	0.600	0.098	0.071
8	1978	2	5	13	595	*	0.15	103.99	-32.4	0.171	0.925	0.714	0.098	0.051
9	1978	2	5	14	486	*	0.15	104.03	-32.4	0.143	0.916	0.688	0.103	0.053
10	1978	2	5	15	260	*	0.15	104.03	-32.9	0.087	0.891	0.618	0.117	0.049
11	1978	2	22	12	873	*	0.30	100.72	-20.4	0.288	0.944	0.787	0.103	0.085
12	1978	2	22	13	957	*	0.30	100.72	-20.7	0.288	0.944	0.787	0.103	0.080
13	1978	2	22	14	813	*	0.30	100.72	-18.8	0.238	0.940	0.742	0.107	0.093
14	1978	2	22	15	574	*	0.30	100.72	-17.2	0.182	0.929	0.705	0.118	0.084
15	1978	2	22	16	282	*	0.30	100.88	-18.2	0.102	0.901	0.624	0.133	0.054
16	1978	3	1	13	1184	*	0.08	101.48	-32.8	0.311	0.948	0.781	0.085	0.134
17	1978	3	1	14	1015	*	0.08	101.48	-31.3	0.282	0.945	0.768	0.087	0.135
18	1978	3	1	15	750	*	0.08	101.48	-31.6	0.225	0.937	0.736	0.072	0.137
19	1978	3	1	16	441	*	0.08	101.48	-31.2	0.144	0.917	0.678	0.082	0.088
20	1978	3	7	15	830	*	0.18	101.15	-28.9	0.282	0.943	0.757	0.089	0.098
21	1978	3	7	16	548	*	0.18	101.15	-28.8	0.181	0.928	0.708	0.099	0.119
22	1978	3	12	10	1037	*	0.10	99.37	-28.0	0.284	0.947	0.780	0.072	0.148
23	1978	3	12	14	1334	*	0.10	99.50	-26.3	0.351	0.953	0.783	0.088	0.120
24	1978	3	12	15	1015	*	0.10	99.57	-26.0	0.284	0.947	0.781	0.072	0.175
25	1978	3	12	16	884	*	0.10	99.64	-25.5	0.212	0.935	0.720	0.079	0.188
26	1978	3	21	9	852	*	0.15	99.87	-30.8	0.288	0.944	0.752	0.084	0.098
27	1978	3	21	10	1334	*	0.15	99.91	-29.8	0.350	0.952	0.785	0.078	0.088
28	1978	3	21	12	1788	*	0.15	99.91	-29.3	0.437	0.958	0.811	0.072	0.042
29	1978	3	21	13	1780	*	0.15	99.94	-29.0	0.427	0.956	0.811	0.072	0.072
30	1978	3	21	14	1608	*	0.15	99.97	-28.8	0.408	0.958	0.803	0.074	0.088
31	1978	3	21	15	1287	*	0.15	100.01	-28.8	0.350	0.952	0.788	0.078	0.142
32	1978	3	21	16	872	*	0.15	100.01	-28.2	0.288	0.944	0.753	0.084	0.190
33	1978	3	22	14	1558	*	0.15	100.85	-27.3	0.414	0.957	0.811	0.074	0.182
34	1978	3	22	15	1281	*	0.15	100.85	-27.2	0.358	0.953	0.783	0.077	0.181
35	1978	3	22	16	904	*	0.15	100.92	-27.1	0.274	0.944	0.761	0.084	0.188
36	1978	3	24	15	1358	*	0.13	101.32	-25.0	0.358	0.953	0.801	0.072	0.188
37	1978	3	24	16	958	*	0.13	101.32	-23.9	0.287	0.948	0.769	0.078	0.185
38	1978	3	27	15	1438	*	0.15	102.03	-23.7	0.387	0.954	0.811	0.078	0.188
39	1978	3	27	16	1005	*	0.15	102.07	-24.4	0.305	0.948	0.782	0.082	0.248
40	1978	3	28	9	1127	*	0.18	102.24	-31.4	0.311	0.946	0.788	0.086	0.115
41	1978	3	28	10	1488	*	0.18	102.24	-28.4	0.393	0.955	0.814	0.080	0.142
42	1978	3	28	11	1778	*	0.18	102.20	-27.8	0.450	0.958	0.830	0.078	0.131
43	1978	3	28	12	1909	*	0.18	102.17	-27.0	0.480	0.960	0.837	0.075	0.146
44	1978	3	28	13	1909	*	0.18	102.17	-28.4	0.480	0.960	0.837	0.075	0.146
45	1978	3	28	14	1797	*	0.18	102.13	-25.1	0.450	0.958	0.829	0.078	0.102
46	1978	3	28	15	1538	*	0.18	102.07	-24.7	0.393	0.955	0.813	0.078	0.084
47	1978	3	28	16	1184	*	0.18	102.03	-24.4	0.311	0.948	0.784	0.085	0.088
48	1978	3	28	17	695	*	0.18	102.00	-25.3	0.211	0.934	0.733	0.085	0.084
49	1978	4	4	8	837	*	0.15	100.58	-20.8	0.263	0.942	0.748	0.085	0.139
50	1978	4	4	9	1350	*	0.15	100.81	-21.8	0.352	0.953	0.790	0.077	0.075
51	1978	4	4	10	1732	*	0.15	100.85	-22.4	0.434	0.958	0.818	0.072	0.074
52	1978	4	4	11	1994	*	0.15	100.88	-22.2	0.481	0.961	0.828	0.070	0.088
53	1978	4	4	12	2108	*	0.15	100.72	-21.9	0.521	0.962	0.835	0.068	0.127
54	1978	4	4	13	2088	*	0.15	100.72	-21.8	0.521	0.962	0.835	0.068	0.160
55	1978	4	4	14	1957	*	0.15	100.75	-21.3	0.491	0.961	0.828	0.070	0.139
56	1978	4	5	10	1737	*	0.10	101.26	-23.3	0.439	0.958	0.821	0.083	0.130
57	1978	4	5	11	2004	*	0.10	101.28	-22.3	0.497	0.961	0.834	0.081	0.151
58	1978	4	5	15	1595	*	0.10	101.28	-18.7	0.438	0.958	0.821	0.083	0.188
59	1978	4	9	12	2203	*	0.28	102.57	-18.9	0.549	0.963	0.854	0.082	0.147
60	1978	4	9	12	2208	*	0.28	102.81	-18.0	0.549	0.963	0.854	0.082	0.139

POOR COPY
COPIE DE QUALITEE INFERIEURE

Frobisher Bay

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
61	1978	4	9	14	2067	*	0.28	102.81	-17.4	0.518	0.962	0.848	0.084	0.135
62	1978	4	9	15	1810	*	0.28	102.71	-18.8	0.482	0.958	0.836	0.087	0.112
63	1978	4	9	16	1449	*	0.28	102.74	-17.9	0.381	0.954	0.814	0.092	0.085
64	1978	4	9	17	989	*	0.28	102.74	-18.0	0.282	0.945	0.776	0.100	0.053
65	1978	4	9	18	528	*	0.28	102.78	-18.0	0.171	0.926	0.707	0.115	0.075
66	1978	4	10	7	585	*	0.33	102.87	-21.3	0.177	0.927	0.711	0.120	0.059
67	1978	4	10	10	1842	*	0.33	102.84	-18.4	0.487	0.959	0.837	0.081	0.086
68	1978	4	10	11	2114	*	0.33	102.87	-16.4	0.524	0.962	0.848	0.084	0.082
69	1978	4	10	12	2240	*	0.33	102.81	-15.8	0.554	0.963	0.855	0.086	0.107
70	1978	4	10	13	2234	*	0.33	102.81	-14.9	0.554	0.963	0.855	0.086	0.118
71	1978	4	10	14	2093	*	0.33	102.87	-13.4	0.524	0.962	0.849	0.087	0.118
72	1978	4	10	15	1842	*	0.33	102.81	-13.3	0.487	0.959	0.838	0.091	0.085
73	1978	4	12	11	2083	*	0.43	101.87	-9.2	0.535	0.962	0.847	0.084	0.158
74	1978	4	12	12	2224	*	0.43	101.83	-7.5	0.565	0.964	0.852	0.082	0.172
75	1978	4	13	8	1087	*	0.33	101.73	-15.3	0.304	0.946	0.778	0.102	0.104
76	1978	4	13	9	1526	*	0.33	101.70	-13.3	0.403	0.956	0.814	0.084	0.093
77	1978	4	13	10	1889	*	0.33	101.66	-12.7	0.483	0.960	0.834	0.089	0.113
78	1978	4	13	11	2156	*	0.33	101.63	-12.3	0.540	0.963	0.848	0.086	0.118
79	1978	4	13	12	2306	*	0.33	101.58	-10.9	0.570	0.964	0.851	0.085	0.097
80	1978	4	13	13	2313	*	0.38	101.56	-10.4	0.570	0.964	0.850	0.087	0.076
81	1978	4	13	14	2187	*	0.38	101.53	-10.4	0.540	0.963	0.848	0.086	0.080
82	1978	4	13	15	1931	*	0.38	101.49	-8.6	0.483	0.960	0.833	0.091	0.047
83	1978	4	13	16	1585	*	0.38	101.43	-10.1	0.403	0.956	0.812	0.088	0.021
84	1978	4	13	17	1129	*	0.38	101.43	-11.1	0.304	0.946	0.778	0.104	0.040
85	1978	4	13	18	881	*	0.38	101.43	-11.9	0.184	0.931	0.717	0.118	0.008
86	1978	4	14	7	833	*	0.38	101.32	-18.6	0.199	0.933	0.721	0.118	0.077
87	1978	4	14	8	1151	*	0.33	101.43	-18.0	0.309	0.949	0.780	0.102	0.041
88	1978	4	14	9	1822	*	0.30	101.43	-17.8	0.408	0.956	0.813	0.092	0.015
89	1978	4	14	10	1857	*	0.30	101.56	-17.6	0.489	0.961	0.834	0.087	0.086
90	1978	4	14	11	2213	*	0.28	101.53	-17.7	0.546	0.963	0.846	0.082	0.081
91	1978	4	14	12	2302	*	0.25	101.59	-17.8	0.575	0.964	0.851	0.078	0.182
92	1978	4	14	13	2349	*	0.28	101.83	-17.3	0.575	0.964	0.852	0.076	0.085
93	1978	4	14	14	2192	*	0.23	101.70	-17.1	0.546	0.963	0.847	0.077	0.141
94	1978	4	14	16	1669	*	0.20	101.76	-17.9	0.408	0.955	0.818	0.081	0.118
95	1978	4	14	17	1041	*	0.18	101.83	-16.5	0.309	0.948	0.782	0.085	0.196
96	1978	4	15	17	1219	*	0.25	101.09	-12.3	0.331	0.951	0.786	0.082	0.075
97	1978	4	15	18	733	*	0.25	101.12	-12.7	0.221	0.937	0.734	0.103	0.078
98	1978	4	21	7	837	*	0.38	101.49	-23.9	0.237	0.939	0.745	0.113	0.034
99	1978	4	21	8	1287	*	0.33	101.46	-21.6	0.348	0.952	0.794	0.099	0.064
100	1978	4	21	9	1721	*	0.33	101.49	-20.9	0.444	0.958	0.823	0.092	0.077
101	1978	4	21	10	2072	*	0.33	101.49	-19.3	0.524	0.962	0.841	0.087	0.108
102	1978	4	21	13	2533	*	0.30	101.49	-17.4	0.610	0.965	0.858	0.081	0.019
103	1978	4	21	14	2396	*	0.28	101.53	-16.6	0.580	0.964	0.852	0.080	0.033
104	1978	4	21	15	2119	*	0.28	101.53	-16.3	0.524	0.962	0.841	0.083	0.058
105	1978	4	21	17	1261	*	0.28	101.53	-16.1	0.348	0.952	0.794	0.081	0.105
106	1978	4	21	18	764	*	0.25	101.53	-16.0	0.237	0.939	0.745	0.102	0.117
107	1978	4	21	19	314	*	0.28	101.58	-16.4	0.124	0.911	0.655	0.121	0.103
108	1978	4	24	7	848	*	0.28	102.03	-13.0	0.252	0.941	0.757	0.103	0.093
109	1978	4	24	10	2203	*	0.25	102.30	-12.1	0.538	0.963	0.850	0.060	0.044
110	1978	4	25	8	445	*	0.23	103.32	-21.1	0.144	0.917	0.665	0.114	0.053
111	1978	4	25	16	1800	*	0.28	103.58	-11.8	0.463	0.959	0.843	0.087	0.120
112	1978	5	11	20	295	*	0.43	100.72	-7.4	0.111	0.910	0.636	0.142	0.085
113	1978	5	12	6	675	*	0.30	102.61	-14.1	0.225	0.940	0.744	0.109	0.152
114	1978	5	13	7	1142	*	0.30	102.67	-11.6	0.335	0.953	0.787	0.097	0.175
115	1978	5	13	8	1625	*	0.30	102.57	-10.6	0.441	0.960	0.830	0.090	0.165
116	1978	5	13	9	2087	*	0.30	102.87	-8.7	0.536	0.964	0.852	0.085	0.158
117	1978	5	13	10	2466	*	0.33	102.87	-6.9	0.613	0.966	0.868	0.083	0.145
118	1978	5	14	8	727	*	0.33	102.91	-12.3	0.229	0.941	0.749	0.111	0.105
119	1978	5	14	14	2715	*	0.38	102.91	-4.1	0.671	0.968	0.876	0.084	0.187
120	1978	5	14	15	2480	*	0.38	102.94	-4.0	0.616	0.967	0.868	0.087	0.170

POOR COPY
COPIE DE QUALITEE INFERIEURE

Frobisher Bay

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
121	1978	5	14	15	2087	*	0.41	102.94	-3.5	0.536	0.964	0.865	0.092	0.152
122	1978	5	14	17	1856	*	0.41	102.88	-3.6	0.444	0.980	0.834	0.097	0.140
123	1978	5	14	18	1183	*	0.41	102.88	-4.2	0.336	0.953	0.801	0.105	0.126
124	1978	5	14	19	718	*	0.43	102.94	-4.9	0.229	0.941	0.749	0.120	0.106
125	1978	5	14	20	317	*	0.43	102.81	-5.4	0.123	0.914	0.651	0.140	0.082
126	1978	5	17	17	1718	*	0.33	100.58	-7.3	0.454	0.961	0.818	0.080	0.112
127	1978	5	22	15	2843	*	0.48	100.95	-4.6	0.639	0.966	0.857	0.081	0.117
128	1978	5	22	16	2198	*	0.48	100.95	-5.2	0.563	0.965	0.845	0.085	0.103
129	1978	5	22	17	1770	*	0.48	100.98	-5.0	0.459	0.962	0.828	0.100	0.098
130	1978	5	22	18	1306	*	0.48	101.06	-5.3	0.364	0.956	0.797	0.106	0.087
131	1978	5	22	19	836	*	0.48	101.05	-5.9	0.259	0.945	0.753	0.119	0.090
132	1978	5	22	20	420	*	0.48	101.05	-5.7	0.151	0.925	0.681	0.138	0.081
133	1978	7	7	5	509	0	1.35	101.28	4.2	0.190	0.942	0.714	0.166	0.065
134	1978	7	7	6	903	0	1.32	101.26	5.2	0.283	0.955	0.772	0.149	0.062
135	1978	7	7	7	1334	0	1.32	101.26	4.7	0.399	0.962	0.810	0.138	0.058
136	1978	7	7	8	1748	0	1.32	101.22	5.5	0.502	0.967	0.835	0.130	0.064
137	1978	7	7	9	2128	0	1.32	101.19	5.9	0.594	0.970	0.852	0.124	0.070
138	1978	7	7	10	2450	0	1.32	101.15	5.6	0.670	0.971	0.863	0.120	0.064
139	1978	7	7	11	2664	0	1.32	101.09	6.1	0.723	0.972	0.869	0.117	0.063
140	1978	7	7	12	2763	0	1.32	101.05	7.9	0.750	0.973	0.872	0.116	0.063
141	1978	7	7	14	2676	0	1.35	100.88	8.2	0.723	0.973	0.868	0.116	0.058
142	1978	8	8	6	524	0	1.55	100.82	9.3	0.197	0.947	0.717	0.170	0.076
143	1978	8	8	7	924	0	1.55	100.85	10.4	0.308	0.959	0.776	0.153	0.086
144	1978	8	8	13	2366	0	1.50	100.72	18.5	0.673	0.972	0.860	0.123	0.165
145	1978	8	8	14	2278	0	1.50	100.66	18.3	0.645	0.972	0.856	0.124	0.148
146	1978	8	8	15	2046	0	1.47	100.55	20.2	0.589	0.971	0.847	0.127	0.145
147	1978	8	8	16	1718	0	1.47	100.51	20.4	0.511	0.969	0.832	0.132	0.136
148	1978	8	9	6	478	0	1.52	100.51	6.3	0.183	0.946	0.712	0.170	0.109
149	1978	8	9	7	887	0	1.55	100.51	6.6	0.304	0.958	0.772	0.153	0.135
150	1978	8	9	8	1324	0	1.52	100.45	6.2	0.411	0.965	0.807	0.141	0.108
151	1978	8	9	10	2040	0	1.47	100.41	6.6	0.588	0.971	0.846	0.128	0.129
152	1978	8	9	11	2274	0	1.45	100.36	9.5	0.641	0.972	0.853	0.124	0.133
153	1978	8	9	12	2298	0	1.42	100.31	7.5	0.670	0.973	0.858	0.122	0.132
154	1978	9	16	16	976	0	0.53	100.45	4.0	0.315	0.961	0.775	0.117	0.134
155	1978	9	16	17	567	0	0.58	100.48	3.5	0.215	0.951	0.727	0.126	0.123
156	1978	10	16	18	322	*	0.38	100.51	-15.1	0.132	0.934	0.659	0.130	0.148
157	1978	12	2	13	166	*	0.20	99.97	-27.6	0.073	0.886	0.576	0.128	0.086
158	1979	1	12	12	223	*	0.10	100.88	-36.4	0.077	0.892	0.588	0.105	0.047
159	1979	1	12	13	218	*	0.10	100.86	-37.2	0.077	0.882	0.566	0.105	0.052
160	1979	1	12	14	135	*	0.10	100.92	-35.1	0.050	0.870	0.536	0.118	0.037
161	1979	2	2	11	405	*	0.10	102.13	-30.6	0.126	0.912	0.662	0.083	0.059
162	1979	2	2	12	514	*	0.10	102.10	-30.1	0.156	0.922	0.691	0.086	0.070
163	1979	2	2	13	514	*	0.10	102.10	-30.1	0.156	0.922	0.691	0.086	0.070
164	1979	2	2	14	400	*	0.10	102.07	-29.6	0.126	0.912	0.662	0.083	0.053
165	1979	2	2	15	202	*	0.10	102.10	-29.4	0.072	0.883	0.585	0.107	0.047
166	1979	2	3	10	213	*	0.10	102.17	-32.5	0.077	0.886	0.594	0.106	0.054
167	1979	2	3	11	410	*	0.10	102.20	-32.4	0.133	0.914	0.668	0.082	0.074
168	1979	2	3	12	529	*	0.10	102.20	-31.9	0.161	0.923	0.696	0.087	0.076
169	1979	2	3	13	529	*	0.10	102.17	-32.4	0.161	0.923	0.696	0.087	0.076
170	1979	2	3	14	405	*	0.10	102.17	-31.4	0.133	0.914	0.668	0.082	0.076
171	1979	2	3	15	213	*	0.10	102.17	-31.4	0.077	0.886	0.594	0.106	0.054
172	1979	2	17	11	685	*	0.05	101.09	-42.1	0.209	0.935	0.726	0.066	0.149
173	1979	2	17	14	680	*	0.06	100.89	-38.9	0.209	0.935	0.726	0.074	0.129
174	1979	2	17	15	446	*	0.08	100.89	-38.3	0.152	0.921	0.682	0.081	0.128
175	1979	2	22	11	789	*	0.10	101.85	-32.2	0.239	0.940	0.749	0.078	0.163
176	1979	2	22	12	887	*	0.10	101.80	-32.6	0.268	0.944	0.764	0.075	0.241
177	1979	2	22	14	773	*	0.10	101.87	-32.5	0.239	0.939	0.749	0.078	0.184
178	1979	2	22	15	585	*	0.10	102.03	-31.1	0.182	0.929	0.712	0.084	0.136
179	1979	2	22	16	275	*	0.10	102.07	-30.1	0.102	0.900	0.630	0.089	0.082
180	1979	2	23	10	633	*	0.08	102.51	-35.9	0.188	0.930	0.718	0.077	0.092

POOR COPY
COPIE DE QUALITEE INFERIEURE

Frobisher Bay

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
181	1979	2	23	11	834	*	0.08	102.47	-35.3	0.245	0.940	0.755	0.071	0.083
182	1979	2	23	12	1049	*	0.08	102.40	-34.4	0.274	0.944	0.770	0.068	0.072
183	1979	3	4	10	1012	*	0.20	101.48	-29.7	0.243	0.940	0.749	0.085	-0.042
184	1979	3	6	12	1272	*	0.08	100.88	-31.7	0.343	0.952	0.787	0.088	0.188
185	1979	3	6	13	1267	*	0.08	100.85	-30.7	0.343	0.952	0.787	0.083	0.177
186	1979	3	7	12	1324	*	0.10	101.39	-29.2	0.349	0.952	0.785	0.089	0.134
187	1979	3	7	15	829	*	0.13	101.53	-26.4	0.262	0.943	0.759	0.081	0.108
188	1979	3	8	8	234	*	0.15	102.10	-38.3	0.066	0.882	0.610	0.118	0.082
189	1979	3	8	9	587	*	0.15	102.13	-35.2	0.187	0.928	0.717	0.085	0.113
190	1979	3	8	11	1183	*	0.15	102.17	-32.9	0.328	0.950	0.781	0.080	0.184
191	1979	3	8	15	929	*	0.15	102.13	-30.9	0.288	0.943	0.768	0.085	0.138
192	1979	3	8	16	607	*	0.15	102.17	-29.8	0.187	0.929	0.717	0.095	0.082
193	1979	3	9	8	275	*	0.13	102.13	-36.7	0.084	0.895	0.619	0.108	0.047
194	1979	3	9	9	654	*	0.13	102.13	-37.1	0.193	0.931	0.721	0.089	0.077
195	1979	3	9	10	1007	*	0.13	102.10	-35.7	0.275	0.944	0.769	0.080	0.090
196	1979	3	9	11	1251	*	0.13	102.07	-33.8	0.332	0.950	0.783	0.075	0.117
197	1979	3	9	12	1370	*	0.13	102.00	-32.3	0.362	0.953	0.803	0.073	0.142
198	1979	3	9	13	1288	*	0.13	102.00	-31.6	0.362	0.953	0.803	0.073	0.237
199	1979	3	9	14	1204	*	0.13	102.00	-30.7	0.332	0.950	0.782	0.075	0.171
200	1979	3	9	15	945	*	0.13	102.00	-30.4	0.275	0.944	0.758	0.080	0.158
201	1979	3	9	16	592	*	0.13	101.87	-30.4	0.193	0.931	0.720	0.089	0.142
202	1979	3	10	8	317	*	0.15	101.28	-35.4	0.100	0.899	0.624	0.112	0.028
203	1979	3	17	10	1171	*	0.28	103.05	-21.0	0.325	0.949	0.797	0.087	0.129
204	1979	3	17	11	1450	*	0.28	103.21	-20.1	0.383	0.954	0.818	0.092	0.119
205	1979	3	17	12	1598	*	0.28	103.38	-17.3	0.413	0.958	0.828	0.090	0.118
206	1979	3	17	13	1617	*	0.28	103.52	-18.1	0.413	0.958	0.829	0.090	0.093
207	1979	3	17	14	1483	*	0.28	103.65	-17.6	0.383	0.954	0.821	0.092	0.107
208	1979	3	17	15	1183	*	0.28	103.76	-17.4	0.325	0.949	0.801	0.087	0.107
209	1979	3	17	16	826	*	0.28	103.86	-17.2	0.243	0.938	0.753	0.105	0.101
210	1979	3	24	9	1030	*	0.10	100.07	-30.2	0.287	0.946	0.782	0.073	0.118
211	1979	4	12	13	2311	*	0.71	103.45	-8.4	0.585	0.963	0.883	0.107	-0.019
212	1979	4	14	15	1529	*	0.48	102.81	-6.7	0.408	0.958	0.823	0.105	0.101
213	1979	4	14	17	1088	*	0.48	102.88	-7.0	0.308	0.948	0.785	0.114	0.080
214	1979	4	15	14	2250	*	0.38	101.58	-9.5	0.555	0.963	0.848	0.089	0.044
215	1979	4	17	7	703	*	0.38	101.48	-14.3	0.216	0.936	0.732	0.115	0.075
216	1979	4	17	8	1174	*	0.38	101.48	-14.3	0.325	0.950	0.787	0.102	0.085
217	1979	4	17	9	1655	*	0.38	101.43	-13.5	0.424	0.957	0.818	0.085	0.044
218	1979	4	17	10	2086	*	0.38	101.45	-13.0	0.504	0.961	0.837	0.092	-0.005
219	1979	4	17	11	2333	*	0.38	101.43	-12.4	0.561	0.964	0.848	0.089	-0.035
220	1979	4	17	12	2474	*	0.38	101.38	-11.9	0.590	0.965	0.853	0.086	-0.049
221	1979	4	17	13	2477	*	0.41	101.38	-11.2	0.590	0.965	0.853	0.088	-0.052
222	1979	4	17	14	2330	*	0.41	101.38	-10.8	0.561	0.964	0.847	0.081	-0.038
223	1979	4	17	15	2064	*	0.41	101.38	-10.4	0.504	0.961	0.838	0.084	0.004
224	1979	4	17	16	1645	*	0.43	101.38	-10.1	0.424	0.957	0.817	0.100	0.042
225	1979	4	17	17	1152	*	0.43	101.39	-10.1	0.325	0.950	0.788	0.106	0.087
226	1979	4	17	18	587	*	0.43	101.38	-10.1	0.216	0.936	0.732	0.121	0.074
227	1979	4	17	19	278	*	0.48	101.43	-10.3	0.102	0.901	0.627	0.148	0.045
228	1979	4	20	16	1708	*	0.38	101.97	-11.6	0.439	0.958	0.828	0.084	0.085
229	1979	4	20	17	1234	*	0.38	101.83	-12.0	0.341	0.951	0.795	0.101	0.085
230	1979	4	20	18	750	*	0.38	101.88	-12.1	0.231	0.936	0.744	0.113	0.085
231	1979	4	23	7	879	*	0.18	100.98	-22.9	0.247	0.941	0.748	0.081	0.088
232	1979	4	24	6	342	*	0.20	101.60	-25.9	0.139	0.916	0.673	0.111	0.184
233	1979	4	24	7	794	*	0.20	101.83	-23.2	0.252	0.942	0.758	0.094	0.189
234	1979	4	24	8	1284	*	0.18	101.88	-23.2	0.361	0.953	0.802	0.081	0.160
235	1979	4	24	9	1771	*	0.18	101.90	-20.5	0.458	0.959	0.830	0.075	0.150
236	1979	4	24	10	2188	*	0.18	101.97	-19.0	0.536	0.963	0.847	0.071	0.104
237	1979	4	24	11	2449	*	0.18	101.97	-17.8	0.594	0.965	0.858	0.088	0.111
238	1979	4	24	12	2608	*	0.18	101.97	-17.4	0.624	0.965	0.862	0.088	0.079
239	1979	4	24	15	1777	*	0.15	102.07	-15.0	0.458	0.959	0.831	0.071	0.155
240	1979	4	27	8	1403	*	0.15	101.22	-15.2	0.375	0.954	0.802	0.078	0.117

POOR COPY
COPIE DE QUALITEE INFERIEURE

Frobisher Bay

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
241	1979	4	27	9	1887	*	0.15	101.20	-15.9	0.472	0.880	0.829	0.071	0.082
242	1979	4	27	10	2285	*	0.15	101.56	-15.5	0.582	0.883	0.647	0.067	0.048
243	1979	4	27	11	2556	*	0.15	101.55	-14.4	0.608	0.895	0.857	0.065	0.039
244	1979	4	27	12	2691	*	0.15	101.53	-13.7	0.637	0.886	0.863	0.064	0.045
245	1979	4	27	13	2687	*	0.15	101.90	-12.8	0.637	0.885	0.864	0.067	0.034
246	1979	4	27	14	2540	*	0.15	101.97	-12.3	0.608	0.883	0.860	0.068	0.064
247	1979	4	27	15	2251	*	0.15	102.07	-11.6	0.552	0.883	0.851	0.071	0.065
248	1979	4	27	16	1852	*	0.15	102.17	-11.9	0.472	0.886	0.835	0.074	0.126
249	1979	5	11	13	2604	*	0.93	102.47	1.4	0.680	0.985	0.876	0.097	0.068
250	1979	5	11	14	2572	*	0.81	102.44	1.6	0.652	0.956	0.872	0.097	0.075
251	1979	5	11	19	575	*	0.53	102.30	0.3	0.217	0.939	0.736	0.128	0.082
252	1979	5	11	20	292	*	0.51	102.27	-0.8	0.111	0.909	0.643	0.149	0.056
253	1979	5	12	6	825	*	0.43	101.97	-5.5	0.221	0.940	0.739	0.129	0.183
254	1979	5	12	7	1115	*	0.43	101.90	-5.4	0.331	0.953	0.781	0.108	0.160
255	1979	5	12	8	1595	*	0.43	101.83	-4.3	0.437	0.950	0.824	0.089	0.154
256	1979	5	12	9	2056	*	0.43	101.80	-4.3	0.532	0.954	0.845	0.084	0.141
257	1979	6	7	19	904	0	0.51	100.72	1.8	0.293	0.953	0.788	0.121	0.091
258	1979	6	7	20	509	0	0.51	100.72	1.4	0.180	0.939	0.711	0.138	0.068
259	1979	7	4	10	2452	0	1.14	101.29	10.5	0.673	0.971	0.864	0.115	0.080
260	1979	7	4	11	2722	0	1.14	101.28	12.1	0.735	0.973	0.871	0.112	0.046
261	1979	7	4	12	2841	0	1.14	101.22	13.1	0.754	0.973	0.874	0.111	0.042
262	1979	7	4	13	2835	0	1.14	101.19	13.7	0.754	0.973	0.874	0.111	0.050
263	1979	7	4	14	2715	0	1.14	101.19	14.3	0.725	0.973	0.870	0.112	0.052
264	1979	7	4	15	2477	0	1.14	101.19	15.1	0.673	0.971	0.864	0.115	0.066
265	1979	7	4	16	2135	0	1.14	101.18	15.3	0.595	0.970	0.852	0.118	0.092
266	1979	7	4	17	1746	0	1.14	101.15	15.1	0.506	0.967	0.835	0.124	0.094
267	1979	7	4	18	1326	0	1.14	101.15	15.3	0.403	0.963	0.810	0.132	0.085
268	1979	7	4	19	888	0	1.14	101.16	14.4	0.297	0.956	0.773	0.143	0.085
269	1979	7	7	14	2750	0	0.85	99.87	11.8	0.723	0.973	0.868	0.104	0.007
270	1979	7	10	5	483	0	0.88	100.99	2.1	0.185	0.941	0.706	0.160	0.084
271	1979	7	10	6	848	0	0.84	100.98	3.4	0.265	0.955	0.765	0.132	0.112
272	1979	7	10	7	1261	0	0.84	101.02	4.8	0.384	0.962	0.807	0.122	0.113
273	1979	7	10	8	1724	0	0.88	101.05	4.9	0.486	0.967	0.832	0.117	0.101
274	1979	7	10	9	2135	0	0.94	101.05	5.5	0.590	0.970	0.850	0.113	0.078
275	1979	7	10	10	2477	0	1.02	100.99	6.1	0.666	0.971	0.861	0.111	0.043
276	1979	7	10	11	2722	0	1.07	100.95	7.9	0.719	0.972	0.868	0.110	0.014
277	1979	7	10	12	2835	0	1.12	100.92	8.6	0.747	0.973	0.871	0.111	0.006
278	1979	11	16	11	284	*	0.15	101.56	-17.1	0.093	0.914	0.615	0.117	0.057
279	1979	11	16	12	367	*	0.15	101.58	-16.7	0.122	0.925	0.653	0.110	0.065
280	1979	11	16	13	351	*	0.15	101.63	-19.3	0.122	0.925	0.653	0.110	0.071
281	1979	11	16	14	255	*	0.15	101.59	-20.5	0.093	0.914	0.615	0.116	0.057
282	1979	11	19	11	246	*	0.20	102.24	-22.0	0.089	0.911	0.613	0.124	0.057
283	1979	11	19	12	342	*	0.20	102.24	-21.3	0.117	0.924	0.651	0.119	0.071
284	1979	11	19	13	339	*	0.23	102.24	-20.6	0.117	0.924	0.651	0.120	0.073
285	1979	11	19	14	246	*	0.23	102.27	-20.4	0.088	0.911	0.612	0.128	0.064
286	1979	11	22	11	190	*	0.36	101.36	-18.5	0.078	0.906	0.590	0.150	0.053
287	1979	11	27	14	213	*	0.20	101.12	-20.1	0.080	0.893	0.558	0.134	-0.002
288	1979	11	28	11	188	*	0.15	100.55	-23.3	0.057	0.881	0.560	0.125	0.026
289	1979	11	29	12	285	*	0.15	100.01	-22.9	0.082	0.908	0.583	0.115	0.029
290	1979	11	29	14	177	*	0.15	100.01	-24.1	0.064	0.889	0.547	0.126	0.010
291	1979	12	18	12	118	*	0.13	100.21	-29.8	0.047	0.875	0.526	0.123	0.064
292	1979	12	18	13	103	*	0.13	100.14	-29.1	0.047	0.875	0.527	0.123	0.066
293	1979	12	20	12	135	*	0.10	101.26	-34.8	0.045	0.873	0.530	0.117	0.027
294	1979	12	20	13	139	*	0.10	101.19	-35.1	0.045	0.873	0.525	0.117	0.024
295	1980	1	17	11	171	*	0.25	102.56	-29.1	0.063	0.879	0.567	0.143	0.032
296	1980	1	17	12	255	*	0.25	102.47	-27.1	0.090	0.896	0.615	0.132	0.047
297	1980	1	17	13	255	*	0.25	102.51	-26.3	0.090	0.895	0.615	0.132	0.047
298	1980	1	17	14	174	*	0.23	102.44	-25.5	0.062	0.879	0.567	0.139	0.030
299	1980	2	3	13	548	*	0.25	102.44	-28.6	0.181	0.923	0.697	0.114	0.040
300	1980	2	3	14	435	*	0.25	102.40	-28.5	0.133	0.914	0.659	0.120	0.035

POOR COPY
COPIE DE QUALITEE INFERIEURE

Frobisher Bay

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
301	1980	2	2	15	232	*	0.25	102.37	-25.4	0.077	0.888	0.585	0.135	0.025
302	1980	2	12	15	343	*	0.43	100.81	-12.0	0.124	0.911	0.651	0.138	0.074
303	1980	2	21	11	784	*	0.13	98.47	-33.8	0.223	0.926	0.731	0.083	0.111
304	1980	2	28	12	980	*	0.13	101.28	-32.4	0.283	0.947	0.772	0.076	0.228
305	1980	2	28	13	985	*	0.13	101.32	-31.0	0.283	0.947	0.772	0.076	0.213
306	1980	2	28	13	1140	*	0.13	101.83	-31.5	0.305	0.944	0.778	0.077	0.103
307	1980	2	28	14	877	*	0.13	101.83	-31.2	0.276	0.945	0.765	0.080	0.126
308	1980	2	28	15	718	*	0.13	101.88	-31.7	0.218	0.936	0.738	0.085	0.127
309	1980	2	28	16	389	*	0.13	101.70	-32.1	0.138	0.916	0.671	0.087	0.109
310	1980	2	29	9	402	*	0.10	102.40	-31.6	0.144	0.918	0.681	0.090	0.128
311	1980	2	29	10	747	*	0.10	102.37	-31.8	0.228	0.937	0.743	0.079	0.135
312	1980	2	29	11	1014	*	0.10	102.34	-31.0	0.282	0.945	0.774	0.074	0.128
313	1980	2	29	12	1158	*	0.10	102.27	-30.0	0.311	0.946	0.786	0.072	0.128
314	1980	2	29	13	1152	*	0.13	102.13	-30.2	0.311	0.949	0.785	0.077	0.123
315	1980	2	29	14	1005	*	0.13	102.07	-29.8	0.282	0.945	0.772	0.079	0.130
316	1980	2	29	15	744	*	0.13	102.03	-29.0	0.228	0.937	0.741	0.085	0.130
317	1980	2	29	16	430	*	0.13	101.83	-29.9	0.144	0.918	0.678	0.088	0.080
318	1980	3	1	9	474	*	0.15	100.82	-31.2	0.144	0.916	0.673	0.101	0.045
319	1980	3	1	10	807	*	0.15	100.72	-27.2	0.228	0.937	0.734	0.083	0.085
320	1980	3	1	11	1052	*	0.15	100.85	-26.3	0.282	0.945	0.782	0.087	0.085
321	1980	3	17	9	801	*	0.13	102.07	-29.6	0.243	0.940	0.752	0.083	0.184
322	1980	3	17	10	1178	*	0.15	102.07	-29.0	0.325	0.949	0.790	0.080	0.147
323	1980	3	17	11	1470	*	0.15	102.10	-29.3	0.383	0.954	0.810	0.078	0.128
324	1980	3	17	12	1639	*	0.15	102.07	-28.1	0.413	0.958	0.819	0.074	0.085
325	1980	3	17	13	1630	*	0.18	102.07	-27.2	0.413	0.958	0.819	0.076	0.087
326	1980	3	17	14	1488	*	0.18	102.07	-26.6	0.383	0.954	0.810	0.080	0.120
327	1980	3	17	15	1184	*	0.18	102.03	-26.7	0.325	0.950	0.790	0.084	0.133
328	1980	3	17	16	804	*	0.20	101.87	-26.9	0.243	0.940	0.752	0.085	0.133
329	1980	3	31	15	1581	*	0.33	101.78	-15.5	0.410	0.956	0.818	0.084	0.110
330	1980	3	31	16	1185	*	0.33	101.78	-15.4	0.328	0.950	0.790	0.100	0.131
331	1980	3	31	17	741	*	0.33	101.78	-15.7	0.228	0.936	0.743	0.111	0.105
332	1980	5	9	9	1887	*	0.84	102.47	-2.4	0.522	0.963	0.846	0.116	0.283
333	1980	5	9	10	2233	*	0.87	102.47	-1.8	0.600	0.966	0.862	0.114	0.328
334	1980	5	9	11	2499	*	0.87	102.47	-0.8	0.655	0.966	0.871	0.112	0.325
335	1980	5	9	12	2641	*	0.87	102.40	0.7	0.683	0.966	0.874	0.110	0.308
336	1980	5	9	13	2658	*	0.88	102.37	1.8	0.683	0.966	0.874	0.111	0.288
337	1980	5	9	14	2509	*	0.89	102.37	2.0	0.655	0.966	0.870	0.112	0.286
338	1980	5	9	15	2239	*	0.99	102.34	2.4	0.600	0.965	0.861	0.115	0.304
339	1980	5	9	16	1881	*	1.02	102.34	2.4	0.522	0.963	0.847	0.120	0.261
340	1980	5	9	17	1448	*	1.02	102.34	3.6	0.428	0.958	0.824	0.127	0.237
341	1980	5	9	18	983	*	1.02	102.27	3.4	0.319	0.952	0.789	0.137	0.222
342	1980	5	9	19	558	*	1.04	102.24	2.1	0.208	0.937	0.733	0.153	0.159
343	1980	5	10	17	1845	*	0.81	101.83	2.1	0.430	0.959	0.822	0.110	0.158
344	1980	5	11	6	861	*	0.58	101.80	-3.6	0.217	0.938	0.735	0.121	0.082
345	1980	5	11	7	1108	*	0.58	101.80	-3.6	0.327	0.952	0.789	0.117	0.130
346	1980	5	11	8	1578	*	0.58	101.80	-3.2	0.434	0.960	0.822	0.108	0.146
347	1980	5	11	9	2006	*	0.58	101.80	-2.6	0.528	0.964	0.844	0.102	0.183
348	1980	5	11	10	2371	*	0.58	101.80	-1.8	0.607	0.965	0.856	0.098	0.184
349	1980	5	11	11	2641	*	0.58	101.80	-0.5	0.662	0.966	0.867	0.098	0.138
350	1980	5	11	12	2779	*	0.58	101.78	0.7	0.690	0.968	0.870	0.095	0.130
351	1980	5	11	13	2773	*	0.58	101.75	0.7	0.690	0.968	0.870	0.095	0.145
352	1980	5	11	14	2618	*	0.58	101.78	1.2	0.662	0.966	0.866	0.098	0.197
353	1980	5	11	15	2349	*	0.58	101.73	1.9	0.607	0.966	0.856	0.098	0.211
354	1980	5	11	16	1978	*	0.58	101.78	1.3	0.529	0.964	0.844	0.102	0.219
355	1980	5	11	17	1532	*	0.56	101.73	1.9	0.434	0.960	0.822	0.108	0.213
356	1980	5	11	18	1058	*	0.58	101.73	1.6	0.327	0.952	0.789	0.117	0.198
357	1980	5	11	19	628	*	0.61	101.73	1.5	0.217	0.938	0.735	0.132	0.141
358	1980	5	11	20	287	*	0.58	101.73	0.7	0.111	0.910	0.641	0.153	0.082
359	1980	5	12	8	650	*	0.58	101.53	-3.8	0.221	0.940	0.738	0.128	0.136
360	1980	5	28	17	1795	*	0.81	101.83	0.2	0.484	0.962	0.834	0.108	0.190

POOR COPY
COPIE DE QUALITEE INFERIEURE

Frobisher Bay

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 1      2   3  4  5    6 7    8      9     10     11     12     13     14     15
361   1980  5 25 13 1257 * 0.88 101.53  -0.4  0.380  0.958  0.808  0.111  0.153
362   1980  5 26 13  854 * 0.51 101.53  -1.4  0.272  0.947  0.785  0.118  0.148
363   1980  5 26 20  468 * 0.53 101.59  -2.1  0.169  0.929  0.699  0.138  0.095
364   1980  5 29 16 2126 0 1.09 101.39  -0.4  0.579  0.956  0.851  0.119  0.030
365   1980  6 15  8 1815 0 0.89 100.24   2.8  0.511  0.958  0.828  0.107  0.076
366   1980  6 20  8 1768 0 1.02 100.41  11.8  0.809  0.958  0.830  0.119  0.088
367   1980  6 30  8 2173 0 1.07 100.41  12.6  0.601  0.966  0.847  0.116  0.084
368   1980  7  8 13 2780 0 1.17 100.89   8.9  0.749  0.973  0.872  0.112  0.081
369   1980  7  8 14 2850 0 1.14 100.82  11.0  0.722  0.972  0.868  0.112  0.109
370   1980  7 10 15 2084 0 1.14 100.85   7.7  0.850  0.970  0.848  0.119  0.113
371   1980  7 17 12 2732 0 1.24 100.82  12.7  0.735  0.973  0.889  0.114  0.084
372   1980  8  3 14 2368 0 1.24 101.48  13.8  0.882  0.972  0.864  0.116  0.156
373   1980  8  3 15 2118 0 1.22 101.48  11.0  0.607  0.971  0.856  0.120  0.174
374   1980  9  1 15 1841 0 1.02 100.41   8.7  0.481  0.959  0.824  0.122  0.129
375   1980  9  1 16 1288 0 1.04 100.41   8.8  0.400  0.958  0.804  0.129  0.139
376   1980  9  1 17  872 0 1.04 100.41   8.6  0.301  0.950  0.770  0.138  0.146
377   1980  9  1 18  458 0 1.07 100.38   8.8  0.181  0.946  0.709  0.158  0.136
378   1980  9  4 10 1819 0 0.84 101.40   3.6  0.465  0.968  0.828  0.117  0.104
379   1980  9  4 11 1870 0 0.84 101.48   5.2  0.522  0.970  0.841  0.113  0.100
380   1980  9  4 12 2004 0 0.84 101.48  11.5  0.552  0.971  0.845  0.111  0.088
381   1980  9  4 13 1998 0 0.88 101.48  12.7  0.552  0.971  0.846  0.112  0.100
382   1980  9  4 15 1280 0 0.88 101.43   7.8  0.384  0.959  0.808  0.125  0.115
383   1980  9  4 17  853 0 0.89 101.43   7.8  0.285  0.958  0.789  0.138  0.112
384   1980  9  4 18  432 0 0.88 101.43   7.7  0.174  0.946  0.703  0.153  0.108
385   1980  9 12  9 1058 0 0.81 100.99   2.1  0.339  0.952  0.788  0.131  0.118
386   1980  9 12 11 1880 0 0.87 100.89   4.4  0.478  0.969  0.828  0.121  0.084
387   1980  9 12 13 1794 0 0.88 100.95   8.5  0.507  0.970  0.834  0.119  0.105
388   1980 10 12 15  718 0 0.43 101.32  -4.9  0.237  0.953  0.749  0.117  0.101
389   1980 10 13 16  407 0 0.43 101.29  -5.7  0.158  0.940  0.687  0.131  0.094
390   1980 10 13 11  928 0 0.53 101.36  -5.4  0.289  0.958  0.771  0.116  0.085
391   1980 10 13 12 1090 0 0.53 101.39  -5.2  0.318  0.960  0.783  0.118  0.100
392   1980 10 13 13 1037 0 0.53 101.36  -4.8  0.316  0.960  0.783  0.115  0.111
393   1980 10 13 14  907 0 0.53 101.36  -4.3  0.289  0.958  0.771  0.118  0.114
394   1980 10 13 15  874 0 0.53 101.39  -4.7  0.231  0.952  0.743  0.128  0.113
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